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Characterizing Middle School Students' Physical Literacy: A Sequential Mixed Methods Study

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CHARACTERIZING MIDDLE SCHOOL STUDENTS' PHYSICAL LITERACY: A SEQUENTIAL MIXED METHODS STUDY

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ABSTRACT

The purpose of this dissertation study was (a) to characterize middle school students' levels of physical literacy (PL) and PL domains by gender, grade, socioeconomic status (SES), weight status, race, and ethnicity; and (b) to capture PL trajectory change as a result of receiving a theory-informed pedagogical workshop. Participants (N = 350) in sixth and seventh grades were recruited from a public middle school located in a southeastern U.S. state. These students completed the second version of the Canadian Assessment of Physical Literacy (CAPL-2). A subsample (n = 49) received a pedagogical workshop (four sessions over eight weeks), participated in two focus-group interviews (pre and post workshop), and completed the CAPL-2 upon intervention. Demographic data were collected using questionnaire, while weight and height were collected using stadiometer and weight scale to calculate body mass index (BMI) percentile. I found (a) gender-based differences in PL (favor boys; d = 0.29), cognitive (favor girls; d = 0.35), physical (favor boys; d = 0.59), and affective domains (favor boys; d = 0.32); (b) grade-based differences in cognitive (favor seventh grade; d = 0.32) and physical (favor sixth grade; d = 0.33) domains; (c) SES-based differences in PL (d = 0.52), cognitive (d = 0.33), and behavioral (d = 0.63) domains, all favoring high SES group; (d) BMI-based differences in PL (d = 0.68), physical (d = 0.90), and affective (d = 0.40) domains, all favoring normal BMI group; and (e) race-based differences in cognitive (d = 0.44) and behavioral (d = 0.78) domains all favoring White. The subsample, after workshop intervention, showed improvement in PL, and cognitive and affective domains (d: 0.29 – 0.42) as assessed by CAPL-2. Interview data delineated a positive trend of PL change by virtue of physical activity type and intensity, perceived motives, and barriers of physical activity participation. The findings of this study bear

significant implications for future PL interventions. PL is a dynamic state that can be improved across populations through purposeful PE curriculum and instruction.

INTRODUCTION

Physical literacy (PL) is a revived concept (Whitehead, 1993, 2001) that has received global attention in policy, research, and practice discourses in recent decades (Jurbala, 2015; Roetert & Jefferies, 2014). The development of PL has become a major goal of school physical education (PE) in the United States (U.S.), as the theme of the national PE standards has been revised from fostering "physically educated persons" to "physically literate individuals" (Roetert & Jefferies, 2014; Society of Health and Physical Educators [SHAPE America], 2014; The Aspen Institute, 2015a, 2015b). PL refers to "the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life" (Whitehead, 2013a, p. 29). It has been defined variably dependent upon the contexts in which PL is developed (e.g., PE or youth sport), geographic origins (e.g., Canada, UK, U.S., etc.), or theoretical perspectives (e.g., motivation, physical activity, cognitive learning; see detail in Appendix: Extended Review of the Literature). Despite the varying definitions, experts have reached a consensus that the ultimate goal of PL development is physical activity engagement across the entire lifespan (Whitehead, 2010). Previous studies that have examined youth comprehensive PL achievement were mostly based in Canada or areas outside of the U.S., while fewer empirical studies in the U.S. have investigated youth PL level and even fewer have carried out intervention to foster youth PL in schools, especially through quality PE. In the U.S., SHAPE America has endorsed several metrics to assess specific PL components, but not overall PL (Dyson et al., 2011; Dyson & Williams, 2012; National Association for Sport and Physical Education [NASPE], 2010, 2011; Plowman & Meredith, 2013; Plowman et al., 2006; Welk, De Saint-Maurice Maduro, Laurson, & Brown, 2011; Welk & Meredith, 2010).

The majority of the empirical studies on students' PL have been conducted in Canada. These studies have mainly used the CAPL or the Physical Literacy Assessment for Youth to assess PL and its components (Bélanger, Barnes et al., 2018; Bélanger, Humbert et al., 2016; Delisle Nyström, Barnes, & Tremblay, 2018; Delisle Nyström, Traversy, et al., 2018; Dutil et al., 2018; Healthy Active Living and Obesity Research Group [HALO], 2017a; Kiez, 2015; Kozera, 2017; Law et al., 2018; Saunders et al., 2018; The Aspen Institute, 2015a; Tremblay, Longmuir et al., 2018). CAPL was designed to assess four PL domains including behavioral (e.g., physical activity participation), physical (e.g., movement skills and fitness), cognitive (e.g., knowledge and understanding) and affective (e.g., motivation and confidence) domains (HALO, 2017a). Each domain is assigned a specific score and the sum score across the four domains amounts represents overall PL level. The validity and reliability of CAPL have been examined by a number of studies (Boyer et al., 2013; Francis et al., 2016; Gunnell, Longmuir, Barnes, Bélanger, & Tremblay, 2018; Gunnell, Longmuir, Woodruff, et al., 2018; Longmuir et al., 2017; Longmuir, Woodruff, Boyer, Lloyd, & Tremblay, 2018; Robinson & Randall, 2017; Scott, Thompson, & Coe, 2013; Tudor-Locke, McClain, Hart, Sisson, & Washington, 2009). PLAY has six separate assessment tools including PLAY*fun* (assessing motor competence), PLAY*basic* (a shortened assessment of motor competence), PLAY*coach* / PLAY*parent* (assessing environment participation, motor competence, motivation, confidence and understanding used by a coach or a parent, respectively), PLAY*self* (assessing environment participation, self-described PL, and relative ranking of literacies), and PLAY Inventory (a checklist for the type of activities participated during the past 12 month). PLAY*self*, PLAY*coach*, and PLAY*parent* provide a composite score to quantify PL; however, they still lack of reported validity and reliability in peer reviewed journals. In addition, PLAY does not contain assessments for physical activity and

health-related fitness. Thus, CAPL is the most valid and reliable instrument to date to comprehensively assess PL.

Students' Levels of PL and PL Components, and Association with Sociodemographic Factors

Several studies in Canada examined differences in the PL by sociodemographic and anthropometric factors including age, gender, body mass index (BMI), and socioeconomic status (SES) using CAPL (Bélanger et al., 2018; Delisle Nyström, Barnes, et al., 2018; Delisle Nyström, Traversy, et al., 2018; Dutil et al., 2018; Kiez, 2015; Kozera, 2017; Law et al., 2018; Lee et al., 2018; Longmuir et al., 2015; Saunders et al., 2018; Tremblay, Longmuir, et al., 2018). These studies often utilized a large sample size and reported a low level of PL ranging from 59.3 to 64.9 out of 100 for children aged eight to 12 years old. PL composite score favored boys over girls (Bélanger et al., 2018; Dutil et al., 2018; Tremblay, Longmuir, et al., 2018) with a small effect size (d = 0.07 - 0.20), older students over younger students (e.g., d = 0.27 [age: eight vs. 12]; Dutil et al., 2018; Tremblay, Longmuir, et al., 2018), and students with healthy weight status over those with unhealthy weight status (d = 0.30; Delisle Nyström, Traversy, et al., 2018). In addition, PL components as assessed by PLAY showed similar results for motor competence, ranging from 39.35 (third graders) to 68.28 (12^{th} graders) out of 100, although self-reported affective and cognitive PL domains were relatively high (i.e., M = 40.23 out of 52; Kozera, 2017). PLAY-based assessment also showed more favorable results for environmental participation in boys than in girls (M = 17.78 vs. 16.17 out 24; Kozera, 2017).

More studies examined PL components across sociodemographic factors. Some PL components favored boys, while other favored girls (Kozera, 2017; Longmuir et al., 2015; Tremblay, Longmuir, et al., 2018). Dutil (2017) reported motor competency and three fitness tests (i.e., PACER, timed plank, and grip strength) favoring boys and the sit-and-reach favoring

girls across several grade levels. Similarly, PL components such as health-related fitness (Tremblay, Longmuir, et al., 2018), motor skills (Butterfield, Angell, & Mason, 2012; Kozera, 2017; Tremblay, Longmuir, et al., 2018), physical activity and sedentary behavior (Bélanger et al., 2018; Chen, Liu, & Schaben, 2017), and knowledge (Chen, Gu, & Liu, 2018; DiLorenzo, Stucky-Ropp, Vander Wal, & Gotham, 1998; Longmuir et al., 2018) also varied by age. Compared to the lower socio-economical schools, the higher SES schools showed more favorable motor competence (Kozera, 2017). Abnormal BMI may hinder PL development, leading to mental, cognitive, physical, and behavioral problems among youth (Bischoff et al., 2017; Cote, Harris, Panagiotopoulos, Sandor, & Devlin, 2013; Erickson, Robinson, Haydel, & Killen, 2000; Freedman, Khan, Dietz, Srinivasan, & Berenson, 2001; Morrison, Shin, Tarnopolsky, & Taylor, 2015; Nieman & Leblanc, 2012; Pollock, 2015). Delisle Nyström, Traversy, et al. (2018) reported that healthy weight children scored higher across all PL domains, while Kozera (2017) found children and adolescents demonstrated a negative association between BMI and motor competence. Race and ethnicity have not been examined by prior research as moderating factors for PL. The first research purpose of this dissertation study was to explore middle school students' levels of PL and PL domains by sociodemographic and anthropometric factors including age, gender, race/ethnicity, SES, and weight status in a U.S. public middle school setting.

The Need for Developing PL and Existing Interventions

Developing PL in youth is important for both public health and educational reasons (Castelli, Centeio, Beighle, Carson, & Nicksic, 2014; Whitehead, Durden-Myers, & Pot, 2018). Physical inactivity is associated with morbidities (Althoff et al., 2017) and mortality (Lee et al., 2012). Worldwide cost associated with physical inactivity was $67.5 billion in 2013 (Ding et al.,

2016). However, only 20% adolescents between 13 to 15 years old worldwide meet the physical activity recommendation (Hallal et al., 2012). The decline of physical activity during adolescent years further attests the public health problem at this developmental stage (Brodersen, Steptoe, Boniface, & Wardle, 2007; Dumith, Gigante, Domingues, & Kohl, 2011; Nader, Bradley, Houts, McRitchie, & O'Brien, 2008). Developing PL is critical as it equips students with physical and mental properties needed for lifetime physical activity participation. Developing PL is also educationally meaningful (Whitehead et al., 2018) and PE is a primary setting to foster PL (Castelli, Barcelona, & Bryant, 2015; Castelli et al., 2014; Clark, 2007; The Aspen Institute, 2015a, 2015b; United Nations Educational Scientific and Cultural Organization [UNESCO], 2015; Whitehead, 2010). The relatively low level of PL achievement (averaged from 59.3 to 64.9 out of 100; Bélanger et al., 2018; Delisle Nyström, Barnes, et al., 2018; Delisle Nyström, Traversy, et al., 2018; Dutil et al., 2018) calls for purposeful interventions.

Few interventional studies have attempted to promote students' overall PL achievement. As an exception, McGrane, Belton, Fairclough, Powell, and Issartel (2018) conducted a school-based randomized control trial that involved 482 student participants (age: 12 to 15 years old) to examine students' motor competence, health-related fitness, and physical activity behavior as a result of receiving the Youth-Physical Activity Towards Health (Y-PATH) program. Informed by the youth physical activity promotion model, Y-PATH puts forth a multi-component intervention involving students, parents/guardians, teachers, and a supportive website. The control group received regular PE class. The results showed time-by-treatment interaction effects of Y-PATH on total object control and total locomotor after six months of intervention. In addition, Kozera (2017) conducted a quasi-experimental study that examined the effect of the PE-based Running, Jumping and Throwing (RJT) program on PL achievement (Kozera, 2017).

The study recruited 199 students (boys = 57.22%) with 111 students receiving intervention of RJT PE (i.e., 3 classes per week; 30 – 50 minutes per class) and 76 students receiving regular PE. The eight weeks of RJT intervention yielded a time ($p < 0.01$) and a group ($p < 0.05$) impact on motor competence.

A diversity of strategies is documented in the literature to promote achievement in PL components. First, some studies followed a theory-driven approach including the Youth Physical Activity Promotion Model (O'Brien, Issartel, & Belton, 2013), Social Ecological Model (Bélanger et al., 2016; Castelli et al., 2014), or the Health Belied Model (Castelli et al., 2014) to render effects on achievement in PL components (e.g., physical activity). Second, existing studies have more frequently employed quantitative research methods than qualitative research methods or mix methods (Bélanger et al., 2016; Collins, Martindale, Button, & Sowerby, 2010; George, Rohr, & Byrne, 2016; Johnstone, Hughes, Janssen, & Reilly, 2017; Kiez, 2015; Kozera, 2017; Lavery, Sinker, & Pickering, 2017; Lee et al., 2018; Mateus, Santos, Vaz, Gomes, & Leite, 2015; McGrane et al., 2018; O'Brien et al., 2013; UNESCO, 2015; Vulliamy, 2011; Wainwright, Goodway, Whitehead, Williams, & Kirk, 2018). These studies also suggested a minimum of four – six weeks of intervention duration to yield effectiveness (George et al., 2016; Lee et al., 2018). Given the authentic statement from Whitehead (2013a, 2013b) that PL is a state of embodied capability with a disposition to enable the individual to pursue purposefully the four integral domains, the current PL assessment seems more competent to measure capabilities than to reflect embodiment and the integrated self. Therefore, inquiries from qualitative methods alongside with quantitative approaches (i.e., mixed methods) may be better suited to obtain situated and detailed information about students' physical embodiment of PL in relation to their behavioral trajectory toward PL.

Lastly, the importance of motivation for PL development was emphasized by Whitehead (2010) that "physical literacy can be described as a disposition characterized by the motivation to capitalize on innate movement potential to make a significant contribution to the quality of life" (p. 12). Chen (2015) asserted that self-determined motivation is foundational to the appropriate functioning of PL attributes (e.g., knowledge, skillfulness, confidence, etc.) that a typical *physically literate individual* should demonstrate. The role of PE in child development is essentially through providing learning and motivational opportunities (Koekoelk, Knoppers, & Stegeman, 2009). Motivation is an integral aspect for developing PL as "children's motivation in physical education is both an innate mental disposition and an acquired/learned attribute" (Chen, 2015, p. 125). McClelland (2013) revealed that the self-determination theory (SDT; Deci & Ryan, 1985) is a highly relevant and applicable theory to examine students' motivation for PL development. Specifically, motivations for fun, knowledge learning, movement skills development, movement competence, and relatedness were found to significantly influence PL achievement (McClelland, 2013). Self-determined motivation is believed to be the heart of PL development which reinforces students' ongoing development to become physically literate including learning activities in PE across the four PL domains (i.e., cognitive, behavioral, physical, and affective; McClelland, 2013). Therefore, based on the above literature review, I designed a SDT-informed pedagogical workshop as intervention for PL promotion and evaluated its impact using mixed methods.

Research Purposes

The first purpose is to characterize middle school students' levels of PL and PL domains by gender, grade, SES, weight status (i.e., healthy vs. unhealthy BMI levels), race, and ethnicity.

The second purpose is to capture students' PL journeys as a result of receiving a theory-driven pedagogical workshop.

METHODS

Research Design

This dissertation study employed a sequential intervention mixed methods research design. The first research section for purpose one involved a cross-sectional developmental design (Thomas, Nelson, & Thomas, 2015) by capturing middle school students' PL and PL domain levels as well as by gender, grade, SES, BMI, race, and ethnicity. The research section to address purpose two involved the explanatory case study design to characterize low-achieving and high-achieving students' journey toward PL as they received the pedagogical workshop. The explanatory case study is a type of case study typically used for investigating phenomenon that has not been specifically studied and has a possible causality implication (Yin, 2014). This design suits the purpose of investigating the potential operational links of the cause-and-effect relationship of the intervention over time (Hancock & Algozzine, 2011; Yin, 2014).

Setting and Participants

Setting. The study took place in one suburban public middle school located in a southeastern U.S. state. Population proportion by race in this state is 63.0%, 32.6%, 1.9%, 1.7% and 0.8% for White, African American, Asian, two or more races, and American Indian or Alaska Native; while Hispanic or Latino account for 5.2% of the population (United States Census Bureau, 2018). Based on the National Center for Education Statistics, the participating middle school had three grades (sixth, seventh, and eighth grades) with a total of 483 students. Students to teacher ratio was 18.58 and White (n = 254) is the primary race followed by Black (n = 197) and other (n = 32). The school has roughly even number of boys (n = 224) and girls (n = 259). More than half of the students (61.7%) are eligible for free (n = 250; 51.8%) or reduced-price (n = 48; 9.9%) lunch.

Participants. For the quantitative research part, 350 (boys = 48.6%; from eight classes) participants were recruited from 6th (*n* = 212; boys = 55.2%) and 7th grades (*n* = 165; boys = 40.6%). Eighth grade students were not recruited in this study due to age limit, as the CAPL-2 is designed to assess students aged eight to 12 years old. Table 1. below shows the characteristics of these participants. For the qualitative part of the study, I used criterion-based purposeful sampling (Sparkes & Smith, 2014) to select 49 participants from eight PE classes (sixth - seventh grades took PE separately; two to nine students in sixth and seventh grades per class) who were categorized as low-achieving (*n* = 26) or high-achieving (*n* = 23). Students were placed into the low PL group if their CAPL composite score were lower than 68.1 for girls or 71.1 for boys (i.e., *beginning* and *progressing* PL developmental stages; HALO, 2017a); whereas students were placed into the high PL group if their CAPL composite score were greater than 68.2 for girls or 71.2 for boys (i.e., *achieving* and *excelling* PL developmental stages; HALO, 2017a). The low- and high-achieving students within each class were matched as dyads by gender (boys and girls) to receive the workshop intervention. The students recruited in this study were free of any physical restrictions. Before the study took place, Institutional Review Board (IRB) of a major public research university approved the study protocol**.** Signed written child assent, parental consent, and principal consent forms were secured.

Table 1. Characteristics of the Sample

Variable Name	Category	Frequency	Percentage (%)
Gender			
	Male	170	48.6
	Female	180	51.4
Grade			
	Sixth Graders	193	55.1
	Seventh Graders	157	44.9
Ethnicity			
	Hispanic/Latino	20	6.3
	Not Hispanic/Latino	300	93.7
Race			
	American Indian or Alaska Native	10	3.1
	Asian	2	0.6
	African American/Black	118	36.9
	Native Hawaiian or other Pacific Islander	1	0.3
	White	140	43.8
	Two or more races	36	11.3
SES			
	Free lunch	173	49.4
	Reduced-price lunch	22	6.3
	Self-paid lunch	155	44.3
BMI Category			
	Underweight	7	2.4
	Normal BMI	166	57.4
	Overweight or Obese	54	18.7
	Obese	62	21.5

Note. SES: socioeconomic status; BMI: body mass index.

The Pedagogical Workshop

A subsample of students (n = 49) received four sessions of the carefully designed pedagogical workshop as an intervention during school hours. To foster learning in the workshop, high/low PL dyads were created based on students' baseline PL levels to create heterogeneity that would facilitate a conducive motivational climate (Epstein, 1988, 1989). The workshop included two modules informed by the self-determination theory (Deci & Ryan, 1985): *motivational* and *informational* modules. These two modules were developed based on the Heart PL model that targets core motivation aspects for nurturing PL achievement

(McClelland, 2013). Table 2. shows the scope and sequence of the workshop sessions. The workshop was offered every two weeks in the course of seven weeks. Each session lasted for 20 to 30 minutes, starting with the motivational module followed by informational module.

The motivational module embraced three motivation aspects, including seeking and reinforcing fun, movement competence, and being social (see detail in Appendix: Workshop Materials). Whitehead (2010) believes that motivation stands as an essential aspect for the developments of all other PL domains. This module was designed to foster PL development in behavioral (e.g., physical activity participation), physical (health-related fitness) and affective domains (confidence and motivation). The goal of this module was to increase confidence, motivation, and perceived fun in physical activity experiences.

The informational module addressed the cognitive (e.g., knowledge and understanding) and physical (e.g., motor skills) domains of PL. Knowledge and understanding is integral to PL (McClelland, 2013) so the informational module emphasized concepts related to health-related fitness and physical activity (Dyson & Williams, 2012; Longmuir et al., 2018; NASPE, 2010, 2011). The knowledge-based intervention permeated each workshop session with focused instruction along with tailored handouts. This module also offered tips on how to use and strengthen motor skills and physical activity, and to overcome barriers in skill acquisition and performance.

Workshop implementation. The four workshop sessions were implemented by me during regular PE classes on Mondays (four classes) and Tuesdays (four classes) starting from late September to mid November. The PE teachers called out the names of the participants after dress-out, and sent them to me to attend the workshop that took place in an adjacent teacher's work room equipped with a conference table and chairs. I welcomed the participants and informed them to be

seated to receive instruction. Printed handouts (see Appendix C.) were distributed to each participant. I conveyed the motivation module first followed by the information module. For the motivation module, the students were asked to identify and write down during the past week the physical activities they did, difficulties/barriers experienced when engaging in those activities, and their socialization experiences. I helped students (a) recall the fun of these activities as a motivation reinforcement, (b) indicate interest in future participation, (c) analyze and provide solutions for their difficulties in performing these activities and being social with others, and (d) understand the importance of fitness-related exercises. The information module was delivered with instruction on knowledge of health-related fitness and physical activity as well as strategies for improving skill performance and overcoming barriers to physical activity. I used pedagogical skills such as interaction and encouragement to facilitate student engagement. At completion of each workshop, students submitted the completed worksheets to me and then went back to their normal PE class organized by PE teachers.

Table 2. The PL Promotion Workshop: Scope and Sequences

Domains	Activities	Procedures	Targets	Goals
Cognitive	Instructions & Communications	Distribute handouts (4 sessions); short review; present concepts related to physical activity, fitness & health.	Promote knowledge and understanding; support the need for perceived competence.	Competent in knowledge attainment, innovation, and transferability.
Physical	Explanations & Demonstrations	Distribute handouts on motor skill tips; explain movement skills in real sport/exercise; provide strategies to overcome difficulties in skill performance.	Improve movement skills & capabilities to address skill-related challenges; support the need for perceived competence.	Achieve motor competence.

(table cont'd.)

Domains	Activities	Procedures	Targets	Goals
Behavioral	Communication & Encouragement	Survey perceived fun and barriers in physical activities in the past week; have students recall active experiences; reinforce fun; help students address difficulties.	Reinforce fun experiences; foster predilection to seek fun; overcome barriers for activity participation; encourage intrinsic/integrated regulation.	Foster intrinsic motivation for physical activity.
Affective	Communication & Encouragement	Survey perceived challenges and barriers in fitness-enhancing exercises and social activities; help them address difficulties with suggestions and encouragement.	Gain confidence and skills for socialization; understand the importance of fitness; stay motivated for physical activity; support the needs for relatedness and competence.	Become competent in socialization and motivated for health-related fitness.

Instrumentation

PL level. To address the first research purpose, I used the CAPL-2 (HALO, 2017a) to assess students' PL levels and used a survey to measure the sociodemographic variables. Table 3. below shows an overview of the CAPL-2. CAPL-2 has separate assessments for the four domains including knowledge and understanding, motivation and confidence, physical competence, and daily physical activity behavior. Students' PL achievement in each of the four domains was quantified and aggregated to compute a composite score (100 in total). Based on the composite score, a PL level was assigned to interpret achievement: *beginning* (girls: < 52.1; boys: < 51.6), *progressing* (girls: 52.1 – 68.1; boys: 51.6 – 71.1), *achieving* (girls: 68.2 – 75.3; boys: 71.2 – 79.1), and *excelling* (girls: > 75.3; boys: > 79.1). Based on the CAPL protocol, students are expected to reach at least the "achieving" level. CAPL-2 is the revised version of CAPL-1, and is a reliable and valid PL assessment (Francis et al., 2016; Gunnell, Longmuir,

Barnes, et al., 2018; Gunnell, Longmuir, Woodruff, et al., 2018; Longmuir et al., 2015; Robinson & Randall, 2017; Scott et al., 2013).

Table 3. CAPL Instrument Overview: Domain, Tools, and Scoring

Domains (100 points)	Subdomains	Tools	Units	Points
Physical (30 points)	Health-related Fitness	-PACER (15/20 m)	Laps (count)	10
		-Isometric Plank Hold	Time (in second)	10
	Motor Competence	-CAMSA (I.e., fundamental movement skill and agility)	14 levels	10
Behavioral (30 points)	Daily Behavior	-Pedometer (daily step count)	Steps per day	25
		-Self-reported number of days per week participating in MVPA	Days	5
Cognitive (10 points)	Knowledge and Understanding	-Physical literacy knowledge questionnaire	Number of items answered correctly	10
Affective (30 points)	Motivation and Confidence	-Self-reported motivation and confidence questionnaire (predilection and adequacy, perceived competence and internal motivation)	Likert scale	30

Note. CAMSA: Canadian agility and movement skill assessment. MVPA: moderate-to-vigorous physical activity; PACER: progressive aerobic cardiovascular endurance run.

The behavioral domain has 30 points that include 25 points for daily step counts (Yamax Digi Walker SW-200, Yamax Corporation, Tokyo, Japan) and five points for self-reported physical activity (i.e., number of days in last week engaging in a minimum of one hour MVPA). Based on the CAPL-2 assessment protocol, valid objective data should be collected for a minimum of three days (10 hours each wear-on day; Colley, Connor Gorber, & Tremblay, 2010; Eisenmann, Laurson, Wickel, Gentile, & Walsh, 2007; Tudor-Locke et al., 2009) with daily step count ranging from 1000 to 30,000 (Pabayo, Gauvin, Barnett, Nikiema, & Seguin, 2010; Tudor-Locke et al., 2009). Pedometer should be positioned on the right side over the hip bone. Student

used a pedometer log sheet recording date, daily step count, and wearing time. The score for daily step count may range from zero (average daily step counts < 2000) to 25 points (average daily step counts > 17999). Previous research showed that it is normal to expect 33.8% of the pedometer loss (Delisle Nyström, Barnes, et al., 2018), so I conservatively expected the pedometer data completion rate to be 65% or higher.

The affective domain, as represented by motivation and confidence, accounts for 30 points and is assessed using a questionnaire (see detail from Appendix B; HALO, 2017a, 2017b). This domain was assessed by four affective aspects including predilection, adequacy, perceived competence satisfaction, and intrinsic motivation (HALO, 2017a). Each affective aspect was assessed using three questions (2.5 points per question) with a total of 7.5 points. Perceived competence and intrinsic motivation were assessed based on a 5-level Likert scale (i.e., 0.5 to 2.5 point); while predilection and adequacy were scaled in the alternative-response format (i.e., first, choose which of the two descriptions is 'most like me'; second, choose 'really true for me' or 'sort of true for me') with different scores (i.e., 0.6, 1.2, 1.8, and 2.5) assigned to corresponding response (HALO, 2017a). This questionnaire has been used in prior research, which showed acceptable validity (*CFI* = 0.91, *RMSEA* = 0.04; Gunnell, Longmuir, Barnes, et al., 2018).

The cognitive domain of CAPL was assessed by a knowledge test (10 total points) that has acceptable validity (knowledge of fitness [$r = 0.12$, $p = 0.03$]; knowledge of physical behavior [$r = 0.13$, $p = 0.01$]) and reliability ($r_{\text{reliability}} = 0.71$; Francis et al., 2016; Longmuir et al., 2018). This assessment covers four areas including *strategies to enhance physical competence, how to carry out daily physical activity workout, understanding of cardiovascular fitness,* and *understanding muscular endurance*. The knowledge test consists of five questions with the first four being multiple-choice questions (one point per question; four points in total)

and the fifth question being fill-out the blank format (one point per blank space; six points in total). The maximal score for the entire knowledge test is 10, with one point awarded to each correctly responded question.

The physical domain accounts 30 points that was assessed using the Canadian Agility and Movement Skill Assessment (CAMSA; 10 points; Longmuir et al., 2017), the isometric plank hold (10 points; Boyer et al., 2013), and the Progressive Aerobic Cardiovascular Endurance Run (PACER; 10 points; Welk & Meredith, 2010). The CAMSA assesses agility and fundamental movement skills including seven performance items (listed sequentially as follows): two-foot jumping (two points), sliding (three points), catching (one point), throwing (two points), skipping (two points), one-foot hopping (two points), and kicking (two points). These seven performances should be completed in a row to demonstrate agility and skills at full speed and with best skill accuracy (see detailed protocol in HALO, 2017a, p. 52 - 53). Two appraisers are needed for the assessment: one for recording time (i.e., time score); and the other for skill assessment using CAMSA scoring sheet (i.e., skill score). Before assessment, special CAMSA layout should be set up (see detailed layout in HALO, 2017a, p. 48). Children should observe two rounds of demonstration with the first one being a slow modeling of (while explaining cue words to each item) moving through the entire course with perfect skill accuracy, and the second one being a demonstration of full speed and best performance accuracy. Children will practice the test twice before formal testing where performance will be timed and scored. To achieve a decent score in CAMSA, the performance needs to be as fast as possible while maintaining high skill accuracy. Both time and skill scores range from zero to 14 with an overall CAMSA score calculated using the formula: (time score + skill score)/2.8. In addition, Plank and PACER were used to measure physical fitness. The isometric plank hold assesses muscular endurance with longer time

recorded being considered good performance. Participants must stay in required body position throughout the recorded time (see protocol in HALO, 2017a, p. 62 - 64). A warning will be given when the first break occurs; and the clock continues if position correction happens within 10 seconds right after the warning. The second violation of position requirement or the position correction time exceeding 10 seconds terminates the testing. Depending on the recorded plank time (in second [0.1]), a score ranging from zero (< 20 seconds) to 10 point (> 110 seconds) is assigned. PACER was used to measure aerobic capacity using a back and forth run across a 15-meter or 20-meter long exercise space. Participants started running with played signal progressively approaching to higher intensity. Participants must step out the distance border line each time they finish the running before the signal, and face back for the next lap of running. The second violation means end of the test. Depending upon the laps completed, a score ranging from zero (< five laps) to ten points (> 49 laps) is assigned. Both genders use the same scoring protocols for CAMSA, Plank, and PACER; however, the score interpretation differs between boys and girls.

Weight status. The body height (feet & inches) and weight (pounds) were measured using stadiometer and weight scale during PE classes to determine weight status (i.e., BMI). BMI was calculated using body weight (kilogram) divided by squared body height (meter^2). BMI percentile was calculated using CDC group-based children's BMI calculator (Centers for Disease Control and Prevention [CDC], 2018b) with specified entries of participants' age (i.e., year, month, day), gender (i.e., male & female), height (feet & inches), and weight (pounds). Based on the BMI percentile, participants' body composition was categorized into underweight (< fifth percentile), normal BMI (fifth – 85th percentile), overweight or obese (≥ 85th percentile), and

obese ($\geq 95^{th}$ percentile; CDC, 2018a). For group comparison purpose, only normal BMI and overweight & obese categories (i.e., two levels) were targeted in this study.

Sociodemographic variables. A series of sociodemographic variables were obtained using a questionnaire (see Appendix B) including questions about gender, race, ethnicity, age (date of birth) and grade (i.e., sixth and seventh), and SES (i.e., free and reduced-price meal plan [FARM] eligibility). School level sociodemographic information including student/teacher ratio, race/ethnicity proportion, gender proportion, free/reduced-price lunch eligibility was retrieved through the National Center for Education Statistics website.

PL journey. I purposefully selected 26 low and 23 high PL achieving students (n = 49) to receive the theory-informed pedagogical workshop. I used mixed methods to capture their PL journey. Specifically, I administered the CAPL-2 and conducted semi-structured focus group interviews (along with field observation notes) before and after the workshop to characterize students' PL journey. The interviews followed a guide shown in Table 4. but involved probe questions to generate in-depth conversations. The interview conversations were recorded using an audio recorder (SONY, ICD – AX412, Sony Electronics Inc., San Diego, CA, USA).

Table 4. Interview Questions Guide

Thank you for agreeing to participate in the focus group interviews. The purpose of these interviews is for me to understand your experiences related to physical literacy. Each interview will take 15-30 minutes. To make sure I hear clearly what you say, I would like to record our conversation. Is that okay? All information collected from interviews will be kept confidential and anonymous. Thank you [upon permission].
Greetings & casual warm-up conversations (routines). 1. Were you physically active in the last week? 2. How many days did you do physical activities in the past two weeks? 3. What type of activities did you do? 4. How intensive were the activities? 5. Why did you do the activities? (reasons) 6. Did you like the activities you did?

(table cont'd.)

Thank you for agreeing to participate in the focus group interviews. The purpose of these interviews is for me to understand your experiences related to physical literacy. Each interview will take 15-30 minutes. To make sure I hear clearly what you say, I would like to record our conversation. Is that okay? All information collected from interviews will be kept confidential and anonymous. Thank you [upon permission].

7. Are there any activities that you originally wanted to do but you did not for some reason? What are the activities, and what were the reasons that stopped you?
8. How do you think of your performance in these activities?
9. Were there any physical barriers to perform these activities? Elaborate.
10. Were there any behavioral barriers? Elaborate.
11. Were there any affective or emotional barriers? Elaborate.
12. Were there any cognitive barriers? Elaborate.
13. Do you think you can do better or more in the performance by overcoming some of the physical and/or mental barriers?
14. Did you see any friends, siblings, or classmates who did better or worse than you in the activities?
    a. What do you think about that?
15. How is your overall experience with attending the workshop [post-interview: 15-16]?
16. Probe positive and negative experiences
    b. What are some positive/negative experiences? – elaborate.
    c. Based on your experiences, what can be modified to make the workshop better?

Thank you for participating in the interview! If there is anything else you like to add, please email those to us (yliu149@lsu.edu).

Data Collection Procedures

The baseline data collection for the quantitative part of the study started in August, 2019. A female and a male certified PE teachers of the participating middle school were reached to inform of the study purpose and procedures. They agreed to participate in the dissertation project immediately. Data collection followed a pre-determined protocol and schedule. In the first two days of data collection, with the teachers' assistance, I collected the data for sociodemographic variables (i.e., gender, age, grade, race/ethnicity, and eligibility for FARM) and those that utilized self-report assessments including a knowledge test (cognitive domain assessment), a physical activity behavior questionnaire (part of behavioral domain assessment), and a motivation and confidence questionnaire (affective domain assessment). The survey was distributed at the beginning of each PE class after informing the students that the survey had no

right or wrong answer, there is no time limit to the survey (HALO, 2017a), and their responses would not impact school standing. Students were organized to sit apart from each other and completed the survey using a pencil. This survey took 14 to 18 minutes to complete in the school gym. Subsequently, I conducted objective assessment of daily physical activity behavior with the assistance of both PE teachers. The pedometers were distributed to each student along with a log sheet, after instructing students how to wear the pedometers and record daily steps information on the log sheets. PE teachers collected the pedometers and log sheets from each participant eight days after the distribution, where the first day was deemed as the trial. In the following eight days after the survey, I administered the physical domain tests including PACER, Isometric Plank Hold, and CAMSA in the school's gymnasium. Specifically, the PACER and Isometric Plank Hold tests were conducted by the PE teachers who recorded students' completed laps in PACER and time in plank holding, while I monitored the entire assessment process. Each assessment session involved 15 to 20 students performing at the same time. The teachers had prior experience with administering the PACER and plank assessments and received training to safeguard data accuracy. After receiving training from me, the teachers also led the assessment of CAMSA using the scoring sheet (see details in HALO, 2017a, p. 54). Boys and girls were assessed separately by the male and female PE teachers respectively. After several scoring trials, both teachers simultaneously assessed 22 students' performances. Correlational coefficient and Cohen's Kappa between two teachers' CAMSA scores were 0.91 ($p < 0.01$) and 0.41 ($p < 0.01$, moderate inter-rater agreement; McHugh, 2012), respectively. Additionally, two graduate students assisted the CAMSA assessment. At the posttest (started from mid-November), data collection protocol was conducted in the same way as the pretest with only 49 workshop attendees completing the assessments.

I used two semi-structured focus group interviews to obtain information about students' physical embodiment and their PL trajectories, before (on Thursday and Friday of the week prior to PE workshop) and after (on Thursday and Friday of the week when the fourth PE workshop was delivered) the pedagogical workshop. All pre and post group interviews were conducted by following an interview guide to prompt the conversations. The interview took place in a quiet and independent meeting room that is near the gym at the middle school. PE teachers called the student interviewees at the beginning of each PE lesson to attend the group interview which involved two to eight students. Students were asked to report their assigned ID (e.g., 'girl A' / 'boy B') first each time before they spoke during the interview conversation, to help identify each individual in transcription. The interviews lasted for 22 to 32 minutes. Each round of interview took two days to complete, which involved eight PE classes.

Data Analysis

Outliers in outcome variable data were screened using Median ± 2.5* MAD (Median Absolute Deviation; Leys, Ley, Klein, Bernard, & Licata, 2013), and were tested for distribution with Shapiro-Wilk test. To address the first research purpose, descriptive statistics was calculated for sociodemographic variables (i.e., *N*, frequency) and PL achievement and achievements of PL domains (i.e., *N*, Mean, Standard Deviation [*SD*]). A correlation coefficient matrix was created to explore the associations among the composite PL score and domain scores. For normal-distributed data, MANOVA and ANOVA were used to examine group differences in PL and PL domains by age and gender. Then, group differences by race/ethnicity, SES and BMI category were analyzed using MANCOVA and ANCOVA respectively with gender and age as covariates (Bélanger et al., 2018; Butterfield et al., 2012; Kozera, 2017; Lavery et al., 2017; Longmuir et al., 2015; Tremblay, Longmuir, et al., 2018). Repeated-measures ANCOVA was conducted to

examine the time (pre vs. posttests) by group (high vs. low PL levels) interaction effect on PL and PL domains. Samuel Stanley Wilks (Λ_{Wilks}), Partial-eta squared (η_p^2), Cohen's d (for $N > 50$; Rosenthal & Rosnow, 1984), and Hedges' g (for $N < 50$; Cohen, 1988) were reported as effect sizes for MANCOVA, MANOVA, repeated-measure ANCOVA, ANOVA, and post hoc analyses. Assumption of homogeneity was examined using Box's M test and Levene's test for MANOVA/MANCOVA and univariate analyses respectively. Welch's ANOVA was performed for data violating homogeneity of variance. For data with violation of normality assumption, one-way non-parametric ANOVA test (Kruskal Wallis) was performed. Alpha was set as 0.05 for significance testing.

To address the second research purpose, I used mixed methods. For the quantitative part, I tested the pre to post changes in PL and PL domains using descriptive and inferential statistics described above. For the qualitative part, I recorded each interview, and transcribed them verbatim. The transcribed interviews were analyzed using Nvivo11 Plus to facilitate thematic analysis (i.e., words frequency query). I used both inductive and deductive (semi) approaches for data analysis to reveal participants' perception and motives / valuing of physical embodiments. For inductive analysis, the thematic analysis was conducted with the five guided stages including: 1) repeatedly perusing/reading raw data to more understand the depth and breadth of the data; 2) creating nodes and patterns; 3) merging similar nodes/patterns to initial categories by actively seeking similarity and nuances between nodes/patterns with similar or shared meanings; 4) defining summative categories by continuing merging initial categories, and 5) writing reports (Smith & Sparkes, 2016). Further, the semi-deductive analysis, partially a reversed way of data management, used the "latent approach" to create raw categories inductively, and then embedded the categories in pre-existent constructs of the physical embodiment process to answer the

research questions in a phenomenological way. Specifically, I attempted to depict the pre-to-post PL change narratives of the participants in terms of physical activity patterns, motives (e.g., enjoyment), and barriers to physical activities. This approach of compartmentalizing at the category level allowed for the categories to be freer toward theorizing the data (Smith & Sparkes, 2016). Eventually, a report was created to describe the findings.

Data Credibility

To increase trustworthiness and data credibility, I immersed myself in the setting for prolonged engagement. Detailed field notes based on observations (55 independent school visits) were taken to capture an enriched description of students' experiences in PE classes. Lastly, I triangulated the data collected from interview transcript, observation, and written records accumulated from workshop and PE classes.

My Role as the Researcher

My background and biases might influence the process and outcome of the qualitative part of the study. I am a male fifth year doctoral student majoring in Kinesiology at a major public research university located in the southeastern U.S. state. I am bilingual with native language being Mandarin Chinese; and English is my second language. My specialized training is in Pedagogical Kinesiology. I am interested in students' PL and how PE and school can be used as the main setting(s) to promote students' PL achievement. I was a competitive swimmer and also coached swimming for a number of years, so I am an avid advocate of performance and achievement. I am a trained researcher who is versed in theories and methodologies. I have accumulated some experiences through PE-based research in the past four years. So, I am fairly familiar with the teaching and learning process in PE. The relationship between me and most of

the student participants is non-acquaintance but I have had some prior communications and interactions with them in research before the study.

RESULTS

Overall PL Level and across Subgroups

Table 5. shows the students' overall PL and PL domain levels. Of the 350 recruited student participants, 206 completed all four PL domain assessments at pretest and therefore were able to generate the CAPL composite score to reflect overall PL level. The bivariate correlation analyses among CAPL composite score and PL domains showed non ($r < -0.01$) to strong correlation strength ($r = 0.72$; Akoglu, 2018; see Table 6.). Table 7. shows the descriptive results of PL and PL domains for pretest across the subgroups including gender, grade, SES, BMI, race, and ethnicity. The CAPL composite score ($Statistic_{df = 177} = 0.99$, $p = 0.27$) and physical domain score ($Statistic_{df = 177} = 0.99$, $p = 0.08$) showed normal distribution. I conducted MANOVA or MANCOVA (after controlling for gender and grade) to test the differences in these outcomes across the subgroups. However, cognitive ($Statistic_{df=177} = 0.95$, $p < 0.01$), behavioral ($Statistic_{df=177} = 0.95$, $p < 0.01$), and affective ($Statistic_{df=177} = 0.94$, $p < 0.01$) domain scores showed normality violation, thus I conducted non-parametric analyses on these variables. As only physical domain data was normally distributed, MANOVA and MANCOVA were not used to examine by group difference in combined outcome variables.

Table 5. Overall PL, PL Domain, and Component Scores

Overall PL	PL Domains	Components	*N*	*M*	*SD*
CAPL Composite Score			206	60.47	11.66
	Cognitive Domain Score		248	7.10	1.63
	Physical Domain Score		282	19.10	4.98
		CAMSA	292	8.03	1.31
		PACER	304	3.41	2.30
		Plank	309	7.34	3.00
	Behavioral Domain Score		210	9.60	5.27
		Pedometer	248	6.58	5.38
		Weekly Active Days	272	3.35	1.48
	Affective Domain Score		264	24.32	4.42
		Predilection	271	6.19	1.62
		Adequacy	272	5.87	1.69
		Intrinsic Motivation	274	6.35	1.31
		PA Competence	273	5.56	1.50

Note. CAPL: Canadian Assessment of Physical Literacy; CAMSA: Canadian agility and movement skill assessment; PA: physical activity; PACER: progressive aerobic cardiovascular endurance run; Plank: isometric plank hold.

Table 6. Correlation Matrix for CAPL Composite Score and Domain Scores

Variables	1	2	3	4	5
1. CAPL Composite Score	1	---	---	---	---
2. Cognitive Domain Score	0.31***	1	---	---	---
3. Physical Domain Score	0.72***	< 0.01	1	---	---
4. Behavioral Domain Score	0.72***	0.23**	0.26***	1	---
5. Affective Domain Score	0.68***	0.01	0.41***	0.22**	1

Note. CAPL: Canadian Assessment of Physical Literacy; ***$p < 0.001$; **$p < 0.01$.

Gender difference. Levene's Test showed homogeneity of variances between group (i.e., girls vs. boys) in CAPL composite score (*Levene Statistic*$_{1, 204}$ = 0.79, p = 0.38) and physical domain score (*Levene Statistic*$_{1, 280}$ = 2.94, p = 0.09). One-way ANOVA showed between gender differences in CAPL composite score ($F_{1, 204}$ = 4.26, p = 0.04, d = 0.25) and physical domain score ($F_{1, 280}$ = 24.21, p < 0.01, d = 0.58), all favoring boys. Kruskal-Wallis Test revealed gender differences in cognitive domain score (*Kruskal-Wallis H* = 7.21, p < 0.01, d = 0.36; favoring girls) and affective domain score (*Kruskal-Wallis H* = 9.81, p < 0.01, d = 0.32; favoring boys); but behavioral domain score (*Kruskal-Wallis H* = 0.52, p = 0.47, d = 0.14) did not differ.

Grade difference. Levene's Test showed homogeneity of variances between group (i.e., sixth vs. seventh grades) in CAPL composite score (*Levene Statistic*$_{1, 204}$ = 2.85, p = 0.09) but physical domain score (*Levene Statistic*$_{1, 280}$ = 4.04, p = 0.05; Welch's ANOVA was used for univariate analysis). One-way ANOVA showed no significant between grade difference in CAPL composite score ($F_{1, 204}$ = 1.24, p = 0.27, d = 0.16); however, Welch's ANOVA showed grade difference in physical domain score ($F_{1, 267}$ = 7.41, p < 0.01, d = 0.33) favoring sixth graders. Kruskal-Wallis Test revealed grade difference in cognitive domain score (*Kruskal-Wallis H* = 6.48, p = 0.01, d = 0.32) favoring seventh graders; but affective domain score (*Kruskal-Wallis H* = 0.85, p = 0.36, d = 0.16) and behavioral domain score (*Kruskal-Wallis H* < 0.01, p = 0.94, d = 0.04) did not differ.

SES difference. Levene's Test showed homogeneity of variances between group (i.e., eligibility for free & reduced-price meal vs. self-paid meal) in CAPL composite score (*Levene Statistic*$_{1, 204}$ = 2.68, p = 0.10) and physical domain score (*Levene Statistic*$_{1, 280}$ = 2.55, p = 0.11). ANCOVA showed there was significant between SES differences in CAPL composite score ($F_{1, 202}$ = 14.13, p < 0.01, d = 0.52) favoring high SES but physical domain score ($F_{1, 278}$ = 1.01, p =

0.32, $d = 0.10$). Kruskal-Wallis Test revealed SES differences in cognitive domain score (*Kruskal-Wallis H* = 5.80, $p = 0.02$, $d = 0.33$; favoring high SES) and behavioral domain score (*Kruskal-Wallis H* = 18.51, $p < 0.01$, $d = 0.63$; favoring high SES); but affective domain score (*Kruskal-Wallis H* = 3.24, $p = 0.07$, $d = 0.24$) did not differ.

BMI difference. Levene's Test showed homogeneity of variances between group (i.e., normal weight vs. overweight & Obesity) in CAPL composite score (*Levene Statistic*$_{7, 186} = 1.06$, $p = 0.39$) and physical domain score (*Levene Statistic*$_{7, 258} = 1.69$, $p = 0.11$). ANCOVA showed between BMI differences in CAPL composite score ($F_{1, 190} = 23.79$, $p < 0.01$, $d = 0.68$; favoring normal weight) and physical domain score ($F_{1, 262} = 61.77$, $p < 0.01$, $d = 0.90$; favoring normal weight), after controlling for gender and grade. Kruskal-Wallis Test revealed between BMI difference in affective domain score (*Kruskal-Wallis H* = 9.31, $p < 0.01$, $d = 0.40$; favoring normal weight); but cognitive domain score (*Kruskal-Wallis H* = 1.97, $p = 0.16$, $d = 0.21$) and behavioral domain score (*Kruskal-Wallis H* = 2.82, $p = 0.09$, $d = 0.25$) did not differ.

Race difference. Levene's Test showed homogeneity of variances between group (i.e., Black/African American vs. White) in CAPL composite score (*Levene Statistic*$_{1, 163} = 0.05$, $p = 0.82$) and physical domain score (*Levene Statistic*$_{1, 202} = 1.26$, $p = 0.26$). ANCOVA showed there were no significant between race differences in CAPL composite score ($F_{1, 161} = 3.42$, $p = 0.07$, $d = 0.24$) and physical domain score ($F_{1, 200} = 0.28$, $p = 0.60$, $d = 0.05$), after controlling for gender and grade as covariates. Kruskal-Wallis Test revealed race differences in cognitive domain score (*Kruskal-Wallis H* = 10.15, $p < 0.01$, $d = 0.44$; favoring White) and behavioral domain score (*Kruskal-Wallis H* = 22.60, $p < 0.01$, $d = 0.78$; favoring White); but affective domain score (*Kruskal-Wallis H* = 0.05, $p = 0.83$, $d = 0.01$) did not differ.

Ethnicity difference. Compared to Hispanic group, Non-Hispanic group showed higher CAPL composite score ($M_{dif.}$ = 3.68, d = 0.31), cognitive domain score ($M_{dif.}$ = 0.10, d = 0.07), physical domain score ($M_{dif.}$ = 0.65, d = 0.12), and affective domain score ($M_{dif.}$ = 2.18, d = 0.47), but behavioral domain score ($M_{dif.}$ = 0.70, d = 0.13).

Table 7. PL Statistics by Gender, Grade, SES, BMI, Race, and Ethnicity

Grouping Variables	Statistics	CAPL Composite Score	Cognitive Domain Score	Physical Domain Score	Behavioral Domain Score	Affective Domain Score
Gender						
Male	*M*	62.36	6.79	20.51	9.16	25.04
	N	90	116	140	87	129
	SD	11.24	1.68	4.49	4.90	4.55
Female	*M*	59.01	7.36	17.71	9.91	23.63
	N	116	132	142	123	135
	SD	11.81	1.54	5.06	5.51	4.19
ΔM (Male - Female)		3.35	-0.57	2.81	-0.75	1.41
Cohen's *d*		0.29*	-0.35**	0.59***	-0.14	0.32**
Grade						
Sixth Graders	*M*	61.40	6.85	19.86	9.49	24.66
	N	100	130	149	105	135
	SD	10.90	1.61	4.66	4.91	4.11
Seventh Graders	*M*	59.59	7.36	18.25	9.71	23.96
	N	106	118	133	105	129
	SD	12.32	1.62	5.21	5.62	4.71
ΔM (Sixth - Seventh)		1.81	-0.51	1.61	-0.23	0.71
Cohen's *d*		0.16	-0.32*	0.33**	-0.04	0.16
SES Category						
Free & Reduced-Price Meal	*M*	57.79	6.88	18.88	8.16	23.88
	N	112	144	160	115	153
	SD	10.69	1.58	4.77	4.56	4.54
Self-Paid	*M*	63.66	7.40	19.38	11.35	24.91
	N	94	104	122	95	111
	SD	12.01	1.66	5.25	5.55	4.20
ΔM (Low - High)		-5.87	-0.53	-0.50	-3.19	-1.03
Cohen's *d*		-0.52***	-0.33*	-0.10	-0.63***	-0.24

(table cont'd.)

Grouping Variables	Statistics	CAPL Composite Score	Cognitive Domain Score	Physical Domain Score	Behavioral Domain Score	Affective Domain Score
Weight Status						
Underweight	*M*	65.20	6.43	23.40	6.00	24.57
	N	6	7	7	5	7
	SD	10.12	0.98	2.41	4.69	4.44
Normal Weight	*M*	63.43	7.26	20.63	10.28	25.05
	N	118	140	162	117	148
	SD	11.27	1.69	4.64	5.53	4.28
Overweight & Obesity	*M*	55.83	6.92	16.49	8.97	23.32
	N	76	88	104	78	95
	SD	11.03	1.57	4.58	4.87	4.48
ΔM (Normal – Overweight & Obesity)		7.59	0.34	4.14	1.31	1.74
Cohen's *d*		0.68***	0.21	0.90***	0.25	0.40**
Race						
All other Races	*M*	57.67	6.87	18.62	9.44	22.77
	N	41	47	78	43	54
	SD	11.97	1.64	5.49	5.34	4.52
Black/African American	*M*	59.59	6.78	19.41	7.43	24.74
	N	69	94	96	70	99
	SD	11.43	1.52	4.62	4.39	4.46
White	*M*	62.30	7.48	19.18	11.24	24.69
	N	96	107	108	97	111
	SD	11.49	1.66	4.92	5.28	4.21
ΔM (Black - White)		-2.70	-0.70	0.23	-3.81	0.04
Cohen's *d*		-0.24	-0.44**	0.05	-0.78***	0.01
Ethnicity						
Hispanic/Latino	*M*	57.06	7.00	18.70	10.25	22.28
	N	15	15	16	16	17
	SD	12.11	1.46	6.02	5.35	4.95
Not Hispanic/Latino	*M*	60.74	7.10	19.34	9.55	24.46
	N	191	233	236	194	247
	SD	11.61	1.64	4.80	5.27	4.36
ΔM (Hispanic - Not)		-3.68	-0.10	-0.65	0.70	-2.18
Cohen's *d*		-0.31	-0.07	-0.12	0.13	-0.47

Note. CAPL: Canadian Assessment of Physical Literacy; BMI: body mass index; *M*: mean; *N*: number; *SD*: standard deviation; *ΔM*: mean differences; PL stages includes four stages incrementally: beginning (girls: < 52.1; boys: < 51.6), progressing (girls: 52.1 – 68.1; boys: 51.6 – 71.1), achieving (girls: 68.2 – 75.3; boys: 71.2 – 79.1), and excelling (girls: > 75.3; boys: > 79.1); ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$.

PL Journey in Light of Receiving the Workshop

Students' PL journey is depicted using both quantitative and qualitative data. The quantitative results are originated from the CAPL assessments, while the qualitative results are

based on the interview data. I originally identified and selected 49 students (26 low PL [*beginning* and *progressing* stages] and 23 high PL [*achieving* and *excelling* stages] students; HALO, 2017a) to receive the workshop. I also identified several students as backup choices to deal with dropout. Figure 1 shows the students' attendance of the workshop sessions. Specifically, Figure 1.a. illustrates that of the 49 purposefully selected attendees, 41, 39, 42, and 35 students participated in the session #1 to #4, respectively. Figure 1.b. portrays the number of attendees by attendance frequency (nobody attended 0 and 24 students attended all four sessions). These results are reported below.

a

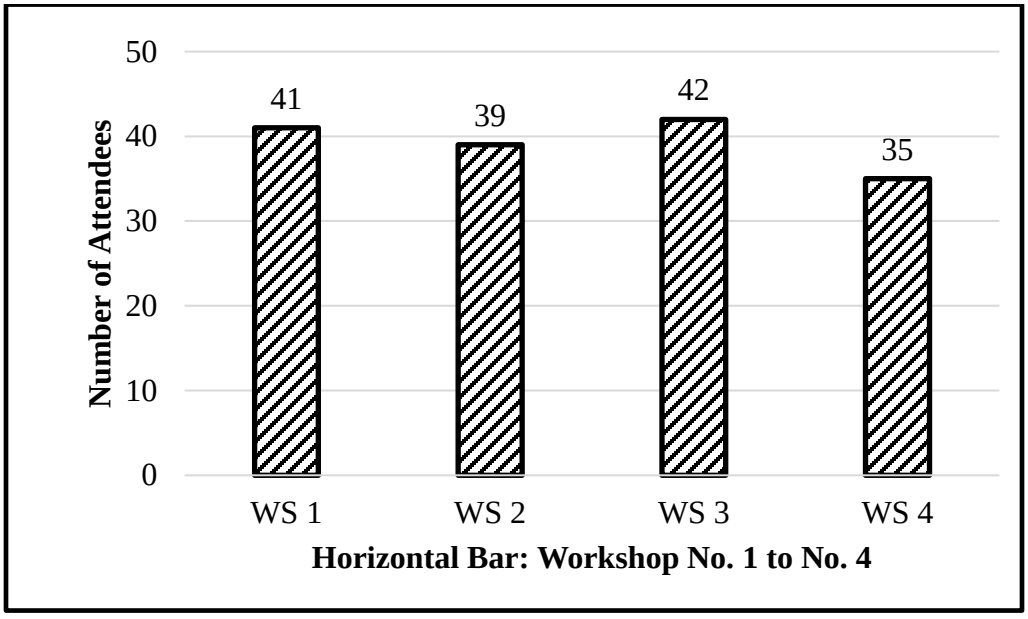


Figure 1. Students' Attendance of the Pedagogical Workshop Sessions, a) Number of Attendees across the Workshop Sessions; b) Number of Attendees by the Attendance Frequency

(fig. cont'd.)

b

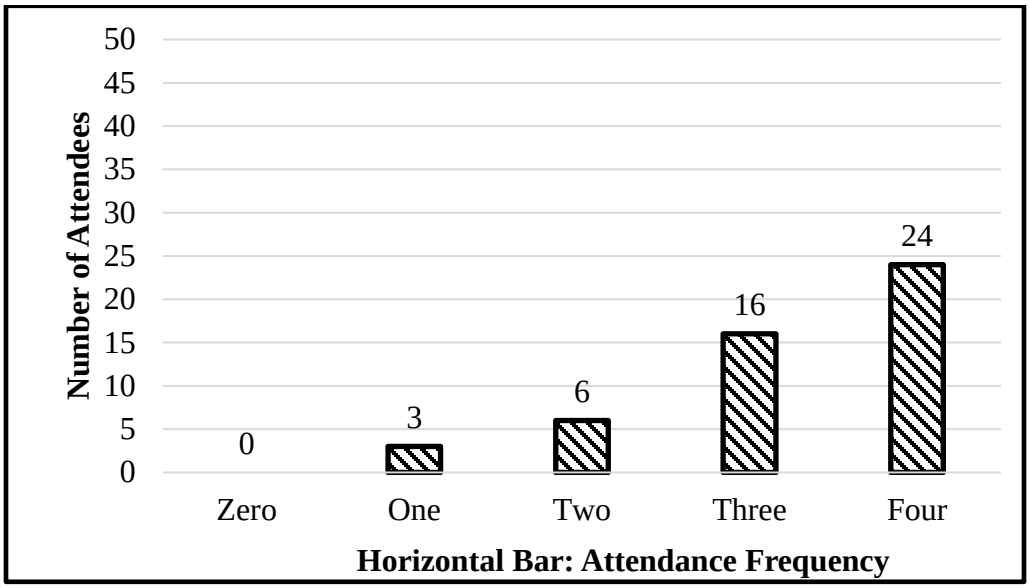


Table 8. shows the descriptive results from CAPL assessments for pre and posttests. Shapiro-Wilk tests showed normal distribution for the CAPL composite score ($Statistic_{df = 80}$ = 0.98, p = 0.15) so I conducted a repeated-measures ANCOVA (i.e., gender and age as covariates) to examine time (pretest vs. posttest) by group (high vs. low PL groups) interaction effect as well as a paired-sample T test to examine pre to post mean change; while cognitive ($Statistic_{df = 80}$ = 0.94, $p < 0.01$), physical ($Statistic_{df = 80}$ = 0.95, $p < 0.01$), affective ($Statistic_{df = 80}$ = 0.90, $p <$ 0.01), and behavioral ($Statistic_{df = 80}$ = 0.95, $p < 0.01$) domain scores were not normally distributed so I conducted Wilcoxon two-related sample tests. Box's test of equality of covariance matrices did not indicate violation of the assumption of homogeneity of variances and covariances for the tests of within-subjects effects (Box's M = 8.06, $F_{3, 88058}$ = 2.52, p = 0.06). There was no significant time effect ($F_{1, 34}$ = 0.27, p = 0.61, η_p^2 = 0.01) for CAPL composite score; however, significant pre-to-post mean difference ($t_{df = 37}$ = 2.38, p = 0.02, d = 0.32) was observed using paired-sample T test. Also, group ($F_{1, 34}$ = 47.43, $p < 0.01$, η_p^2 = 0.58), and time by group interaction ($F_{1, 34}$ = 19.11, $p < 0.01$, η_p^2 = 0.36) effects were observed. Significant pre-

to-post mean differences in cognitive (Z = -2.51, p = 0.01, d = 0.42) and affective (Z = -2.27, p = 0.02, d = 0.29) domain scores were observed, but not for behavioral (Z = -0.76, p = 0.45, d = 0.10) and physical (Z = -1.25, p = 0.21, d = 0.17) domain scores. For the high PL group, the CAPL composite score, and physical, behavioral, and affective domain scores decreased from pretest to posttest (g: 0.12 – 0.31), while cognitive domain score increased (see Table 8.; g = 0.28). In comparison, for the low PL group, CAPL composite score and all four domains increased from pretest to posttest (g: 0.43 – 0.86).

Table 8. Descriptive Results of CAPL Assessments for the Students Intervened by Workshop

Time of Measurement		***Statistics***	**CAPL Composite Score**	**Cognitive Domain Score**	**Physical Domain Score**	**Behavioral Domain Score**	**Affective Domain Score**
Pretest	*High*	*M*	77.41	7.33	24.61	17.67	27.81
		N	18	18	18	18	18
		SD	5.43	1.88	3.19	5.55	2.30
	Low	*M*	51.51	6.19	17.10	7.35	20.87
		N	26	26	26	26	26
		SD	9.98	1.81	5.04	3.98	5.31
	Overall	*M*	62.11	6.66	20.17	11.57	23.71
		N	44	44	44	44	44
		SD	15.35	1.90	5.72	6.91	5.51
Posttest	*High*	*M*	74.90	7.88	23.71	15.87	27.51
		N	16	17	18	15	17
		SD	10.37	2.03	3.61	6.60	2.63
	Low	*M*	60.80	7.17	19.08	9.82	23.47
		N	22	23	24	22	23
		SD	11.59	1.87	4.15	6.95	5.29

(table cont'd.)

Time of Measurement		*Statistics*	CAPL Composite Score	Cognitive Domain Score	Physical Domain Score	Behavioral Domain Score	Affective Domain Score
	Overall	*M*	66.74	7.48	21.07	12.27	25.19
		N	38	40	42	37	40
		SD	13.02	1.95	4.52	7.36	4.77
Post minus Pretest (high PL group)		*ΔM*	-2.51	0.55	-0.89	-1.80	-0.29
		Hedges'*g*	-0.31	0.28	-0.26	-0.30	-0.12
Post minus Pretest (low PL group)		*ΔM*	9.29	0.98	1.98	2.47	2.60
		Hedges'*g*	0.86	0.53	0.43	0.45	0.49
Post minus Pretest (overall)		*ΔM*	4.63	0.82	0.90	0.70	1.48
		Cohen's *d*	0.32*	0.42**	0.17	0.10	0.29*

Note. CAPL: Canadian Assessment of Physical Literacy; BMI: body mass index; *M*: mean; *N*: number; *SD*: standard deviation; *ΔM*: mean differences; $^{**}p < 0.01$; $^{*}p < 0.05$.

Due to absence, I interviewed 45 students at the pretest and 44 students at the posttest. Of the students who received the workshop, 38 participated in both pre and post interviews (retention rate = 77.55%). To characterize middle school students' PL journeys, I focused my data analysis on these 38 students. My interview data informed of students' changes in four categories: (1) physical activity pattern (physical activity type, frequency, and intensity), (2) motivation, (3) barriers, and (4) workshop experience. These results are reported below.

Physical activity type. Table 9. shows the changes of physical activity patterns as identified by interview data. Physical activity pattern is represented by type, frequency, and intensity of physical activities. Of the 38 interviewees, 22 demonstrated more diverse physical activity choices at post-interview than pre-interview, while five interviewees showed less diverse choices and 11 showed no change. The high and low PL groups reported approximately the same amount of physical activity types at both interviews (pre interview: low = 2.3 per student, high = 2.4; post interview: low = 3.3 per student, high = 3.7 per student), but both groups reported more

types of physical activities at the post-interview than the pre-interview. The most commonly reported physical activities were recreational activities or sports, including but not limited to gymnastics, track, swim, basketball, volleyball, baseball, walking, and chasing a dog, etc. Few students reported engaging in planned exercise for fitness improvement purpose.

Table 9. Physical Activity Type and Frequency Reported in the Two Interviews

	PA type	PA frequency
Favor pre	5	6
Favor post	22	12
Equivalent	11	7
No response	0	13

Note. PA: physical activity.

Physical activity frequency and intensity. Table 9. also shows the frequency of physical activity behaviors voiced in the two interviews. I found 13 interviewees reporting more frequent physical activity participation at post-interview than at the pre-interview; six interviewees reported maintaining a stable high weekly physical activity participation frequency; and four interviewees reported less frequent participation at post interview. Two interviewees reported no change for their low weekly participation frequency (≤ 5 per week). The physical activity participation frequency ranged from once per week to seven times per week. In the high PL group, more students (post vs. pre = 80.0% vs. 63.6%) maintained a relatively high weekly participation frequency (≥ 5 per week); meanwhile, in the low PL group, adequate weekly participation frequency increased from pre interview (53.3%) to post interview (66.7%). For the physical activity intensity, the number of interviewees from low PL group reporting light intensity physical activity decreased at post interview (post vs. pre = 5.9% vs. 50.0%); meanwhile, vigorous intensity physical activities were reported more at post interview (post vs.

pre = 47.1% vs. 40.0%). However, vigorous physical activity at high PL group were reported less at post interview (post vs. pre = 53.9% vs. 81.8%).

Motivation. Table 10. shows the change of motives for physical activity. More interviewees reported more intrinsic, extrinsic, and combined motives (three types of motives were determined as defined by Lox, Martin Ginis, & Petruzzello, 2014) for physical activity at post-interview than at pre-interview. The frequently mentioned extrinsic motives included (a) for health benefits and (b) for being social with peers, which were both explained and advocated in the pedagogical workshop. Several interviewees seemed to internalize these two motives of being active. For example, a girl in the high PL group at pre interview stated that "I love playing outside and running and being active." She was more articulate at the post-interview about her motives for being active compared to what she said at the pre-interview, in which she simply stated "I can live a long and good life. … We could be healthy. ... And I love making friends." Another high PL girl at the pre-interview mentioned her motives for being active to be "it made me feel good about myself… just for fun"; but at the post interview she mentioned that "it's a challenge… I Iove the routine, I love the people on the cheer team. … I do this with my friends… I like it because it's just fun to do it… it's good for my health, and it's fun in general." A boy from the low PL group reported his motivation for being physically active is because he likes "playing baseball", enjoys "practice a lot," and likes "these activities that are competitive form." At the post interview, he explained he was physically active because he likes "playing outside with [his] friends and doing active stuff so when [he] get[s] older [he] can be in shape." Another boy also from the low PL group voiced at the pre interview that he loves physical activity because he "get[s] to talk to [his] friends and everything like that." In the post interview, he incorporated health consideration as his physical activity motivation and mentioned that he

"usually want[s] to be active because [his friends will] help [him] stay alive longer and because the healthier you care, the more your body can…". He also said he "have fun doing these activities."

Table 10. Physical Activity Motives and Barriers Reported in the Two Interviews

Time	Intrinsic Motive	Extrinsic Motive	Combined Motive	Barriers	No Barriers	No Reponses to Barriers
Pre	25	19	10	79	26	68
Post	29	25	20	106	38	43

Barriers. Table 10. also shows the interviewees' barriers to physical activity participation across the four PL dimensions (based on four separate interview questions): cognitive, behavioral, physical, and affective (Tremblay, Costas-Bradstreet, et al., 2018). I identified 105 barriers to physical activity participation across the four dimensions as voiced by the interviewees at the post-interview, which are more than those voiced at the pre-interview (n = 77). The total tallies of "no barriers" across the four dimensions also increased from pre to post-interviews. Most barriers did not cast real blockade to physical activity participation. At the pre-interview, affective domain was reported with the fewest barriers (count = 13), followed by cognitive (count = 14), behavioral (count = 19), and physical (count = 33) domains; whilst at the post-interview students narrated barriers mostly from physical domain (count = 49), followed by affective (count = 33), behavioral (count = 20), and cognitive (count = 4) domains.

Frequently mentioned physical barriers included injuries, body overheat, and lack of skill. For injuries, a boy in the high PL group said "I originally started playing football but once I got injured, I kind of dodge myself that I didn't want to experience this pain again so I wanted to do a different sport." A similar voice from a low PL group boy said "I was playing baseball at some point, but cracked my wrist, so I couldn't play"; and a low PL group girl mentioned "because right before track tryouts, I kind of hurt my knee. So, I didn't get to do those." For body

overheat, a girl from the high PL group said “in track you get overheated really quickly… so, yeah, I don't like that…”. Similarly, a girl from the low PL group mentioned “sometimes in track because it gets really hot outside and it gets challenging because you feel like you're going to have a heatstroke.” As examples for lack of skill as a barrier, a low PL group girl mentioned, “I can't balance [well]. I don't think I would be able to do that” (in aquatic sports); while another two girls from the high PL group said “I wanna to play basketball, but I can’t shoot so good,” and “I want to play soccer but I'm really bad at it.”

For barriers in the behavioral domain, the most frequently mentioned was lack of time or schedule conflict. For example, a boy from the low PL group said “I don't really think there is any other sports that I would rather do because my schedule that I have right now is already pretty jam-packed”; and another low PL boy mentioned “I can’t do it because, ...Ur…Like…I study a lot.” A boy from the high PL group mentioned that “the thing that can stop me [from] doing my favorite sports is going to be my grades… if I get bad grades and I bet I would probably get kicked off the team or I'm going to do a lot more work than other people”; and he thought “studying means that you have like less time to play and … cut your sport time out, and put more school work.” A high PL girl complained similarly that “yes, it happens a lot of time, to a point where I have to like miss practice sometimes for study.”

Frequently identified affective domain barriers were pressure, social appraisal, and lack of confidence. For pressure, a low PL girl mentioned “whenever I'm dancing, I feel like I have to fit into this small little box to make myself look like I'm doing what I need to do so I can be a good dancer”; while a girl from the high PL group said “volleyball is a lot of pressure because they have a lot of positions and they have a lot of things that you need to have. You need to have a good mind and you have to be skilled to play volleyball because it’s very technical and it’s

very active." Social appraisals such as feeling embarrassed, criticized, or judged in a group situation were a concern for two boys and two girl in the low PL group, who said "I feel like I'm gonna miss the ball, I'm gonna be laughed", "like Uhm, been through like people taunting you", "I don't really take people's opinions but sometimes I can't take the humiliation", and "… like playing basketball, a lot girls taunt at you; it is kind of nerved to do it because you know they are better than you." Social appraisal was voiced as a concern by students in the high PL group too. For example, one girl said "I was really like upset because I wasn't sure what to do, because I didn't want people judging me or like me to judge myself if didn't make it…I just didn't want to feel that disappointment." Lack of confidence was brought up as another barrier in the affective domain. Three high PL group girls mentioned that "sometimes I lack in confidence because I feel like in softball if I missed the ball, or if I don't catch it or something, then I feel like I just let my whole team down but I'm kind of getting over with it now"; "I wanted to say sometimes I have a lack of confidence in basketball because all you hear is… oh you dookie…."; and 'softball… I'm trying out for it… I try that and I didn't make it and I didn't want to try out again." In the low PL group, a boy mentioned that "sometimes I'll have lack of confidence, but sometimes I'll just like go for it"; and another boy said "I don't have that much confidence in basketball whenever I play because I feel like I'm not that good."

Cognitive domain barriers were mostly represented by lack of knowledge for playing a sport/game. For example, a low PL girl complained "I didn't know how to play it. And I want to play it because I want to do it"; and another low PL girl said "I played volleyball but I am still a little bit confused with all the rotations and ins and outs." Similarly, a high PL boy said "like one time, they, my friends, wanted me to play volleyball, … I didn't know how to fully play it." Another two girls from high PL group also said "I wanna to play soccer but I don't get … most

of the stuff for it," and "volleyball is a lot of pressure because they have a lot of positions and they have a lot of things that you need to have… you need to have a good mind."

Workshop experience. Of the 38 participants who completed the post-interview, 29 shared their perceptions about the four workshop sessions. Overall, they thought the workshop was fun and helpful. They stated that the workshop sessions helped them overcome physical activity barriers, raise health awareness, and have learned knowledge and strategies how to be physically active. Below are several quotes from the interviewees:

> "The interactive stuff was fun, … writing down stuff that we did … helps you think about what you actually did and how you did it. If there's a barrier, how you might have overcome it" (A low PL group student)
>
> "I think it's good because I anticipate more and more in what I do. Yeah." (A high PL group student)
>
> "It taught me some things about physical activities and stuff, … what we can do, and how many days, and hours, … you're supposed to be outside." (A low PL group student)
>
> "Accomplish[ing] goals that we didn't know we can accomplish. I think that the workshops were easy. I mean, it taught you stuff you didn't know about exercises and how it would help the body." (A low PL group student)
>
> "It teaches you some things that you can learn in the long run that'll help you be a better person, a healthier person when you're older. Because things you could do right now." (A high PL group student)
>
> "I had a positive experience… It's fun, I like it… I wish I could do it the whole day." (A low PL group student)
>
> "Y'all make good. I learned a little bit more." (A high PL group student)

"I think the workshop is pretty good" (A low PL group student)

"It teaches me how long you're supposed to exercise for and what is good and bad for your physical life." (A high PL group student)

"I think it's good because it teaches us more stuff than we knew before. Yeah." (A high PL group student)

Several students also shared their suggestions for improving the workshop. Of the few suggestions, the two aspects that could be improved are: (a) to incorporate more real physical exercise / skill practice during the workshop sessions; and (b) to increase difficulty of the workshop content.

DISCUSSION

This study addressed two research purposes: (1) to characterize the sociodemographic and anthropometric differences (i.e., gender, race, SES, BMI, and age) in PL and PL domains; (2) and to capture the PL trajectory as a result of receiving a short-term workshop. I collected mixed methods data in this dissertation study, to address the research purposes. The findings are discussed below.

The Levels of PL and PL Domains

A major finding of this study is that middle school students' PL level was found to be low or at the "progressing stage" (HALO, 2017a) for both genders, warranting the need for purposeful intervention. This observation is in line with findings from other studies across North America (Bélanger et al., 2018; Dutil et al., 2018; Tremblay, Longmuir, et al., 2018). I also observed significant group differences in PL and/or PL domains by gender, SES, BMI, race & ethnicity, and grade.

Gender. Boys scored higher in overall PL, physical and affective domains, but lower in cognitive domain than girls. The higher overall PL score favoring boys is consistent with previous studies (d = 0.07 - 0.20; Bélanger et al., 2018; Dutil, 2017; Kozera, 2017; Longmuir et al., 2015; Tremblay, Longmuir, et al., 2018). Boys' higher score in the physical domain is also observed in prior research (d = 0.17; Bélanger et al., 2018). Essentially, the physical domain assessment of CAPL includes movement skill and health-related fitness, which boys tend to outperform girls as shown in other studies (Belton, Brien, Meegan, Woods, & Issartel, 2014; Butterfield et al., 2012; Chen, Zhu, Mason, Hammond-Bennett, & Colombo-Dougovito, 2016; Chen, Liu, et al., 2017; Kozera, 2017). PE curricula need to incorporate developmentally appropriate strategies and content to foster girls' movement skills and fitness. Boys also scored

higher in the affective domain (d = 0.32) but lower in the cognitive domain. These findings are consistent with prior research (Bélanger et al., 2018; Chen, Liu, et al., 2017). Lack of motivation and confidence among girls are significant barriers to physical activity participation (Allender, Cowburn, & Foster, 2006; Motl, Dishman, Felton, & Pate, 2003; Owen, Smith, Lubans, Ng, & Lonsdale, 2014). Compared to girls, boys need to improve their knowledge about physical activity and fitness due to its behavioral implications (Chen, Liu, et al., 2017; Liu & Chen, 2020).

Grade level. I further observed grade differences in cognitive and physical domain scores, with sixth graders scoring higher in physical domain (d = 0.33) but lower in cognitive domain (d = 0.32) than seventh graders. Several prior studies have found similar grade or age specific trend for cognitive learning (Chen, Liu, & Welk, 2019; Law et al., 2018; Tremblay, Longmuir, et al., 2018; Zhang, Liu, Gu, & Chen, 2019). However, the higher score in seventh grade than in sixth grade for physical domain is inconsistent with the observations made by Trembly, Longmuir, et al., (2018) that examined fitness and skills, and Kozera (2017) that examined motor competence. The inconsistent finding in physical domain relative to age or grade level needs further empirical research investigation.

SES. I used the individual-level data on free/reduced-price meal eligibility to categorize the students to higher or lower SES groups. The higher SES group showed higher scores in overall PL, cognitive and behavioral domains than the lower SES group. The higher SES group also showed higher mean scores in the physical and affective domains, although no statistical significance was observed. This is probably the first study that has investigated SES-based difference in the context of PL. However, prior research has examined SES-based difference in constructs related to PL. For example, the behavioral domain of CAPL assessments measured

both objective and self-reported physical activity. Several prior studies have found similar results that higher SES is associated with more favorable physical activity behavior (Drenowatz et al., 2010; Kantomaa, Tammelin, Näyhä, & Taanila, 2007). Similarly, in the cognitive domain, researchers have found that having adequate knowledge about fitness and physical activity is conducive to active living behaviors (Chen, Liu, et al., 2017; Liu & Chen, 2020; Zhang et al., 2019). Our findings reinforce that learning and health outcomes of lower SES groups remain a concern that demands purposeful intervention. To promote lower SES children's physical activity, motivation, physical competence, and learning, it is important to provide them with safe environments (King & Ling, 2015) and needs-supportive context (Shannon et al., 2018), and facilitate games / free play and outdoor activity opportunity (Johnstone, Hughes, Bonnar, Booth, & Reilly, 2019).

BMI. Compared with the overweight/obese group, the group with healthy BMI scored higher in overall PL (d = 0.68), physical (d = 0.90) and affective domains (d = 0.40). This finding is consistent with Delisle Nyström, Traversy, et al. (2018) that observed significant differences in all four domains (d = 0.05 – 0.44) and overall PL (d = 0.30). Similarly, Kozera (2017) found normal weight children demonstrating higher motor competence than children with unhealthy weight. As evidenced by epidemiology research, having an abnormal BMI may be detrimental to health (Bischoff et al., 2017; Bozkurt et al., 2017; Schwimmer, Burwinkle, & Varni, 2003; Tiffin, Arnott, Moore, & Summerbell, 2011; Vila et al., 2004) among children and adolescents. Overweight or obesity is also a potential barrier to physical activity participation (Bischoff et al., 2017). The finding observed in this dissertation study indicates the need to emphasize tailored instructions for adolescents with unhealthy BMI to increase their PL level.

Race and ethnicity. The cognitive and behavioral domains of the CAPL assessments favored Caucasian/White (with medium effect size) compared to African American/Black. The cognitive domain assessment included knowledge and understanding about physical activity, fitness, and health. The finding is similar to what were observed in two previous studies that used the PE Metrics written test (Chen, Liu, et al., 2017; Zhang et al., 2019). Gaining sufficient level of knowledge and understanding about physical activity and fitness is not only an essential learning outcome in quality PE (SHAPE America, 2014), but also a means to increasing physical activity and curbing sedentary behavior (Chen, Liu, et al., 2017; Liu & Chen, 2020). The lower score in cognitive and behavioral domains (67.8%) in African American/Black students highlight the need for more curricular and instructional attention to them. Data pertinent to ethnicity were also collected in this study to examine PL difference between Hispanic and non-Hispanic. I observed mean differences in overall PL, cognitive, physical, and affective domains, all favoring the non-Hispanic group. Although the sample size of Hispanic students was small, the current results indicate the need to draw more attentions from pedagogy and public health to Hispanic students to promote their PL levels. This study is the first to address this topic; more future research is needed with larger sample size to study Hispanic students' PL levels.

PL Journey in Light of Receiving the Workshop

The other significant finding of this study is that middle school students' PL journeys varied interpersonally. This study is one of the earliest interventions using CAPL to capture students PL change. The promising finding of this study is that my quantitative results demonstrated significant increases of PL and some PL domains over time, in light of receiving the four pedagogical workshop sessions that were informed by the SDT. Each session was

delivered every two weeks across a total of seven weeks that invoked pedagogical ramifications for active lifestyle.

Positive changes were observed in overall PL, and cognitive and affective domains, in light of receiving the pedagogical workshop. Specifically, the net gain of CAPL composite score from pre-test to post-test was 4.63, accounting for 7.45% increase, indicating the malleability of PL when exposed to the pedagogical workshop. The positive change in overall PL was mainly contributed by improvements shown in the cognitive (Cohen's d = 0.42) and affective (Cohen's d = 0.29) domains. Consistent with previous studies, knowledge and understanding (Chen et al., 2019; Demetriou, Sudeck, Thiel, & Höner, 2015; Liu, Wang, Androzzi, Gu, & Chen, 2020; Kiez, 2015) and affective domain variables (e.g., confidence and motivation; Collins et al., 2010; Sánchez-Oliva, Pulido-González, Leo, González-Ponce, & García-Calvo, 2017; Wainwright et al., 2018) can be improved as a result of receiving school-based interventions. Notably, the low PL group students demonstrated improvements in overall PL and four PL domains with small (Hedges'g = 0.43) to high (Hedges'g = 0.86) effect sizes. The high PL group students' scores in overall PL and three PL domains (i.e., physical, behavioral, and affective) showed decline at the posttest compared to pretest with no to small effect sizes; however they also showed improvement in the cognitive domain with small effect size. Celling effect might have contributed to the little to no changes of PL scores for the high PL group students, while the greater change (all positive) in the low PL group suggests learning improvement. Furthermore, the gap for overall PL score between high and low PL group was narrower at posttest (i.e., high – low = 14.10) compared to pretest (i.e., high – low = 25.90). Low PL students' CAPL composite score increased from 51.51 at pretest to 60.80 at posttest, which is an encouraging indication for

their potentiality to pursue higher PL developmental stage from “beginning” to “developing” (HALO, 2017a).

Noticeable changes in physical activity patterns, enjoyment, and barriers are also evident in the focus group interview data. Overall, the students who participated in the workshop sessions showed more diverse and conducive physical activity patterns. In addition, they voiced more barriers to physical activity participation in the post-interview than the pre-interview. I interpret this change as the interviewees becoming more cognizant of their physical, cognitive, affective, and behavioral barriers of physical activity and PL. In fact, their self-reported barriers did not often restrain them from engaging in physical activities of different choices/types, frequency, and intensity. The positive gains shown in CAPL-2 scores and interview data could be attributable the overall physique accrual natural to the youth development, as identified by Tremblay, Longmuir, et al. (2018). However, I was unable to conduct post-test for the control group due to time restraint so cannot tease out the time or maturation effect. The second is the pedagogical repercussion from the workshop imposing motivation and interest, knowledge, and skill on students’ PL trajectory changes. Each workshop session consisted of two modules: motivational and informational modules. The motivational module emphasized and facilitated affective development to help students recall and share their fun experiences over physical activities in the past two weeks. The sharing part enhanced social processing and bondage with peers. The informational module focused on enhancing students’ cognitive and partially physical domains development by teaching physical activity, fitness, and motor skill knowledge and coping strategies. Language of workshop materials were rephrased to become readable to middle school students. As a result, the significant increases in cognitive and affective domains were observed in the quantitative data. However, changes in the physical and behavioral domains of

CAPL-2 assessments were not significant. Unlike the quantitative data, the focus group interview data do support the favorable change of physical activity patterns, especially among the students in the low-performing PL group. The interview data also showed that the students who received the workshop had positive experiences that enhanced their learning, attitude, and behaviors.

Limitations

I acknowledge several limitations of this study. First, I was unable to gather posttest data from a control group due to time constraint. Although both quantitative and qualitative data showed improved PL, the changes may attribute to exposure to the pedagogical workshop intervention and time or maturation effect. Second, this study took place in one single school with unique population and environmental characteristics. Thus, findings of this study can only be generalized to students and schools of similar characteristics. Third, SES level was determined by a student's eligibility for free and reduced-price meal, which only informs one aspect of SES (ideally including economic, educational, and occupational factors; Wolfe, 2015).

CONCLUSIONS

This dissertation study successfully characterized middle school students' PL and PL domains in sixth and seventh grades. To address the first research purpose, by using the validated CAPL-2, I was able to accurately and comprehensively capture students' PL as well as the patterns across several sociodemographic and anthropometric factors (grade, gender, BMI, race/ethnicity, SES). The relatively low PL level (i.e., progressing stage) shown in the sample as evaluated using CAPL-2 protocol indicates the need for more purposeful education for the students to further improve PL and attain the national PE standards (SHAPE America, 2014). The finding also suggests the vulnerability of this population in adopting the physically active lifestyle. It is crucial that PE teachers shall mobilize accountable resources to facilitate and foster students' PL achievement.

The second purpose of my dissertation was the PE-based pedagogical workshop as intervention to increasing middle school students' PL levels. Informed by the SDT and prior research, I designed written materials for four workshop sessions with motivational and instructional modules. Each workshop session was delivered every two weeks to student dyads matched by high and low PL levels. The intervention resulted in favorable quantitative changes in overall PL, and the cognitive and affective domains. The findings from the workshop intervention suggested the feasibility of using short term theory-driven pedagogical intervention to foster middle school student's PL. This study ascertained the CAPL-2's sensitiveness and discernibility to fathom student's PL change as responded to a short-term pedagogical intervention. The workshop also led to positive changes in physical activity patterns, barriers to physical activity participation, and motives to physical activity, as identified from the focus group interview data. The group interview results portrayed the middle school students' varying

trajectories toward becoming the *physically literate individuals* (SHAPE America, 2014). Findings from the focus group interviews indicate that although students' PL journeys may vary, the SDT-driven PL workshop provided the students with conducive motivation and competence, which helped them advance their PL developmental stage. Future PL interventional studies may use SDT to underpin their intervention framework and incorporate motivational and informational strategies as students navigate their PL pathways. Lastly, the greater improvement in PL scores shown in the low PL group and, even more importantly, the narrower PL gap at posttest between the two groups are encouraging results, which support the utility of the SDT-based pedagogical workshop in closing learning disparity. These findings are informative for future school-based research and/or health-related programs to promote PL with tailored educational strategies for all students. In summary, the findings from this study bear significant theoretical and practical implications to PL development through middle school PE.

APPENDIX A. EXTENDED REVIEW OF THE LITERATURE

Paper One

Physical literacy (PL) has become a focus in developing physical education curricula and guiding teachers' instructions. Despite the emerging attention to PL worldwide, there appears to be inconsistent conceptualizations of PL across theoretical perspectives and contexts. In addition, due to the various versions of definitions, there are also considerable confusions concerning how to appropriately measure PL. In this article, I review and synthesize the definitions and assessments of PL documented in the existing literature. Following a standardized literature review protocol, I arrive at three themes. I first present the historic evolution of PL and the various PL definitions. I next synthesize the PL components based on the existing literature. Finally, I discuss the PL assessment issues with regard to assessment component, targeted users, and scoring methods. I conclude with a discussion of the findings for theoretical and practical implications.

Introduction

Physical literacy (PL) has received worldwide attention as a focus for developing physical education (PE) curricula and guiding teachers' instructions. Extensive discussions with regard to PL have been occurring in numerous countries across continents (e.g., Nigeria in Africa (Ejedafiru, 2014), China (Chen, Tang, Chen, & Liu, 2020) in Asia, Czech Republic, Scotland, England, Netherlands, Northern Ireland, Sweden and Wales in Europe (Dowens, Dalziell, & French, 2013; Jurbala, 2015; McKee, Breslin, Haughey, & Donelly, 2013; Newton & Bassett, 2013; Rainer & Davies, 2013; The Aspen Institute, 2015a), Canada and the United States (U.S.) in North America (Roetert & Jefferies, 2014; The Aspen Institute, 2015b), Venezuela in South America (López de D'Amico, 2013; The Aspen Institute, 2015a), and Australia and New

Zealand in Oceania (Sport Australia, 2019; Sport New Zealand, 2019; The Aspen Institute, 2015a). The International Physical Literacy Association (IPLA) defines PL as a concept that focuses on knowledge and understanding for physical activity and health, fundamental motor/movement skills, physical competence and lifelong physical activity participation (Tremblay, Costas-Bradstreet, et al., 2018). In the U.S., the Society of Health and Physical Educators (SHAPE) America recently released the new National Standards and Grade-Level Outcomes for K-12 PE which stipulate that the goal of PE is to foster "physically literate individuals" (Roetert & Jefferies, 2014; SHAPE America, 2014). PL development has become a central goal of school PE. Thanks to the significant political attention to PL domestically and internationally (Balyi, Way, Higgs, Norris, & Cardinal, 2016; Department of Education and Science [DES] / Welsh Office [WO], 1992; Jurbala, 2015; Roetert & Jefferies, 2014; SHAPE America, 2014; The Aspen Institute, 2015a, 2015b), there is a potential to leverage the status of PE in schools through which students could acquire adequate competence and confidence needed for adopting a healthy and active lifestyle.

Despite the emerging attention to PL worldwide, there appears to be inconsistent conceptualizations of PL across theoretical perspectives and contexts (Lounsbery & McKenzie, 2015; Roetert & Jefferies, 2014; SHAPE America, 2014; The Aspen Institute, 2015a, 2015b). In addition, due to the diversity definitions, there is also considerable confusion as to how to appropriately assess PL. Understanding what PL is, what it is comprised of, and how to assess it is crucial to developing PL among millions of K-12 learners. Finding the answers to the above questions would inform future research and practice to foster the "physically literate individual." Therefore, the purpose of this literature review was to synthesize the existing PL definitions, components, and assessments.

Methods

Literature Search

To address the research purpose, a three-step literature search was conducted. First step, direct online literature search through a major public research university's library was conducted in June – July 2018. The keywords used included "physical literacy" or "physical literate" or "physically literate" and "children or adolescent". The search was limited to peer-reviewed journal articles. The second step was to cross-check the texts or references of the identified articles in step one for any missed relevant literature. Articles or documents missed in step one were retrieved through individual library searches, *Google Scholar*, or *Google*. The third step involved separate literature searches using *PubMed* and *PsychInfo*. Four inclusion criteria were applied to identify relevant entries: a) the documents must be available in full-text electronic files including peer-reviewed journal articles, published/unpublished dissertations/theses, books, conference presentations/proceedings, and on-line resources as I intended to include various PL definitions that may be published or announced in different formats; b) documents must entirely or partially address PL; c) documents must be published in English; and d) documents must be published as early as 1900s to July, 2018 to reflect a thorough review.

Literature Review and Screening

After screening the initially retrieved 849 entries, 63 articles were identified that met the four criteria. I then reviewed each paper and organized them in a Microsoft Excel spreadsheet by author name, year of publication, title, document type, and main contents/findings. Only articles that emphasized PL definition, component, and/or assessment survived the topic screening. I then created annotated bibliographies in a Microsoft Word document for the included articles which summarizes them by research purpose, methods, main findings/contents and implications.

The findings of the literature review were organized by PL definition, components, and assessment.

Findings

Definitions of PL

Literacy origin. The term of *literacy* can be interpreted as "being educated or cultured" (Corbin, 2016, p. 15), referring to "the quality or state of being literate" (Merriam-Webster, n.d. b). The adjective form of "literacy", "literate", means being "able to read and write," "versed in literature or creating writing," "lucid" and "polished" and "having knowledge or competence" (Merriam-Webster, n.d. a). The United Nations Educational, Scientific and Cultural Organization (UNESCO; 2004) further defines literacy as: "ability to identify, understand, interpret, create, communicate and compute, using printed and written materials associated with varying contexts" (p. 13).

Literacy plurality. Literacy in applied domains is alluded to as computer literacy, nutrition literacy, numerical literacy, or health literacy (Corbin, 2016; Corbin & Le Masurier, 2014; Gibbs, Ellerbeck, Gajewski, Zhang, & Sullivan, 2018). For example, *health literacy* refers to "the degree to which individuals can obtain, process, understand, and communicate about health-related information and services to make informed health decisions" (Berkman, Davis, & McCormack, 2010, p. 16).

Historical evolution of literacy and PL. The term literacy appeared in PE since 1920s in *Objectives of Physical Education* authored by Franklin Bobbitt (Bobbitt, 1921). In 1930, James Edward Rogers, the director of National Physical Education Service of the Playground and Recreation Association of America, declared that "the public schools are responsible for physical literacy as well as mental literacy" (Rogers, 1930, p. 368). Subsequently, Jesse Williams

brought up the notion of "new physical education" in his book titled *Principles of physical education* (Williams, 1942). Williams postulated the "education through the physical" in opposition to the "education of the physical" as the new PE (Williams, 1942), in which the goal of PE is to foster the "wholeness of individual (children)" (Allan, Turnnidge, & Côté., 2017; Corbin, 2016; Mandigo, Francis, Lodewyk, & Lopez, 2009; Whitehead, 2001). Williams' (1942) idea of "education through the physical" provided guidance for defining PL. Dr. Charles C. McCloy was the first scholar who specifically introduced the term of PL (or motor literacy) in PE. McCloy emphasized that students' physical and motor literacy should be educated in PE class through the mechanical analysis of motor skills (McCloy, 1957a, 1957b). About one decade later, Morrison articulated that a physically literate individual is characterized by one's ability to carry out efficient, creative and competent movements enthusiastically (Morison, 1969; Wall & Muarry, 1994). Concepts that are akin to PL during that time period include "kinesthetic intelligence," "intelligent action" or "skillful action" (Arnold, 1979; Best, 1978). Other concepts such as "literacy in movement" appeared in a flyer distributed by Sports Council in 1991, raising the awareness of sport literacy as a parallel concept to literacy (e.g., ability to read and write; Sports Council, 1991). In 1993, Dr. Margaret Whitehead proposed the first modern definition of PL (Whitehead, 1993), who described that a physically literate individual should "move with poise, economy and confidence in a wide variety of physically challenging situations," and be "perceptive in reading all aspects of the physical environment, anticipating movement needs or possibilities and responding appropriately to these, with intelligence and imagination" (Whitehead, 2001, p. 131).

PL variation. My literature review identified 20 different definitions of PL. I present the original statements of these definitions in Table A.1 and discuss them below (Balyi et al., 2016;

Corbin, 2016; Department for Digital Culture Media and Sport [DCMS]/Strategy Unit, 2002; Higgs et al., 2008; Mandigo et al., 2009; Morison, 1969; Physical and Health Education [PHE] Canada, n.d.-b; The Aspen Institute, 2015a; Tremblay, Costas-Bradstreet, et al., 2018; UNESCO, 2015; Whitehead, 2001, 2013a, 2013b). Among these definitions, some definitions are widely recognized such as Whitehead's (2013a) version that defines PL as a "disposition to capitalize on our human-embodied capability wherein the individual has the motivation, confidence, physical competence, knowledge, and understanding to value and take responsibility for maintaining purposeful physical pursuits and activities throughout the life course" (p. 29). Despite the differences in the constituency components, these definitions mostly agreed that the universal goal of PL is lifelong physical activity participation. PL has been articulated by some experts as an old concept with a new shell (Jurbala, 2015), a metaphor adding little to the public health development. However, researchers have not reached a consensus on what PL is due to their divergent theoretical perspectives as well as the diversity in its applied contexts. These divergence and diversity in perspectives are reflected in delineating (a) philosophical underpinnings, (b) the priorities of PL development, (c) settings for PL development, and (d) strategies for PL development.

Table A.1. A Summary of Physical Literacy Definitions (*N* = 21; listed chronologically)

#	Author	Year	Origin	Approach	Setting	Definitions	Elements	Population
1	Morrison	1969	USA	Performance-Driven	PE	*To be physically literate, one should be creative, imaginative, and clear in expressive movement, competent and efficient in utilitarian movement and inventive, versatile, and skillful in objective movement. The body is the means by which ideas and aims are carried out and, therefore, it must become both sensitive and deft (p.5)*	Creativity, imagination, competence, skillfulness	Children, adolescents and young adults
2	Whitehead	2001	UK	Holistic	General	*This individual moves with poise, economy and confidence in a wide variety of physically challenging situations. Furthermore, the individual is perceptive in 'reading' all aspects of the physical environment, anticipating movement needs or possibilities and responding appropriately to these, with intelligence and imagination (p. 131)*	Competence, confidence, PA, ability to "read" and to "respond"	NA

(table cont'd.)

#	Author	Year	Origin	Approach	Setting	Definitions	Elements	Population
3	DCMS	2002	UK	Performance-Driven	Youth Sport	*The development of agility, balance, coordination, and skill (the ABCs) across a wide range of activities (p. 127)*	Agility, balance, coordination, skill, PA	Six -12 years old
4	Whitehead	2005	UK	Holistic	General	*Physical literacy can be described as the ability and motivation to capitalize on our motile potential to make a significant contribution to the quality of life. As humans we all exhibit this potential, however its specific expression will be particular to the culture in which we live and the motile capacities with which we are endowed (p. 5)*	Ability, motivation, PA	NA
5	Whitehead	2007	UK	Holistic	General	*Motivation, confidence, physical competence, understanding and knowledge to maintain physical activity at an individually appropriate level, throughout life (p. 282)*	Motivation, confidence, physical competence, knowledge, PA	Lifespan

(table cont'd.)

#	Author	Year	Origin	Approach	Setting	Definitions	Elements	Population
6	Higgs et al.	2008	UK	Performance-Driven	Youth Sport	*Physical literacy is the development of fundamental movement skills and fundamental sport skills that permit a child to move confidently and with control, in a wide range of physical activity, rhythmic (dance) and sport situations. Physical literacy also includes the ability to "read" what is going on around them in an activity setting and react appropriately to those events (p.5)*	FMS, sport skills, confidence, control, PA, ability to "read" and to "react"	Zero – 12 years old
7	Mandigo et al.	2009	Canada	Performance-Driven	PE	*The ability to move with competence and confidence in a wide variety of physical activities in multiple environments that benefit the healthy development of the whole person (p. 6-7)*	Competence, confidence, PA	Children
8	Whitehead	2010	UK	Holistic	General	*The motivation, confidence, physical competence, knowledge and understanding to maintain physical activity throughout the life course (p. 11)*	Motivation, confidence, physical competence, knowledge, PA	Children to older adults

(table cont'd.)

#	Author	Year	Origin	Approach	Setting	Definitions	Elements	Population
9	Whitehead	2013a	UK	Holistic	General	*A disposition to capitalize on our human-embodied capability wherein the individual has the motivation, confidence, physical competence, knowledge, and understanding to value and take responsibility for maintaining purposeful physical pursuits and activities throughout the life course (p. 29)*	Motivation, confidence, physical competence, knowledge, valuing, responsibility, PA	Lifespan
10	The Aspen Institute	2015b	USA	Performance-Driven	Youth Sport	*Physical literacy is the ability, confidence, and desire to be physically active for life (p. 9)*	Ability, confidence, desire, PA	12+ years old
11	UNESCO	2015	Global	Holistic	PE	*Physical Literacy can be described as the motivation, confidence, physical competence, knowledge and understanding to maintain physical activity throughout life, and refers to the skills needed to obtain, understand and use the information to make good decisions for health (p. 20)*	Motivation, confidence, physical competence, knowledge, PA	Children and young people

(table cont'd.)

#	Author	Year	Origin	Approach	Setting	Definitions	Elements	Population
12	Jurbala	2015	Canada	Holistic	Sport	*The dynamic communication between the embodied self and the physical environment, which continuously integrates perceptive reading of, and appropriate response to, physical challenges (p. 377)*	Ability to "read" and to "respond"	Unspecified
13	Sport for Life Society	2016	Canada	Performance-Driven	Sport	*The fundamental movement skills, fundamental sports skills, motivation, knowledge, and understanding that enable an individual to read their environment and make appropriate decisions while moving confidently and with control in a wide range of physical activities in both indoor and outdoor environments (p. 73)*	Physical skills, motivation, knowledge, understanding, ability to "read", decision making, confidence, control, and PA	Unspecified
14	Sport for Life Society	2016	Canada	Performance-Driven	Sport	*Individuals are physically literate when they have acquired the skills and confidence to enjoy a variety of sports and physical activities (p. 73)*	Skills, confidence, enjoyment, PA	Parents

(table cont'd.)

#	Author	Year	Origin	Approach	Setting	Definitions	Elements	Population
15	Sport for Life Society	2016	Canada	Performance-Driven	Sport	*Individuals are physically literate when they demonstrate competence and confidence in fundamental movement skills and foundation sport skills combined with the ability to read their environment and make appropriate decisions. Physical literacy allows individuals to enjoy a variety of sports and physical activities (p. 73)*	Competence, confidence, FMS, physical skills, ability to "read", decision making, enjoyment, and PA	Coach & instructor
16	Sport for Life Society	2016	Canada	Performance-Driven	Sport	*Individuals who are physically literate move with competence and confidence in a wide variety of physical activities in multiple environments that benefit the healthy development of the whole person (p. 73; similar to PHE Canada definitions, n.d.).*	Competence, confidence, PA	Educator and health practitioner

(table cont'd.)

#	Author	Year	Origin	Approach	Setting	Definitions	Elements	Population
17	Allan, Turnnidge, & Côté	2017	Canada	Integrated	Sport	*The motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life; physically literate individuals maintain a self-awareness that encourages moral behavior and meaningful connections with others in physical activity contexts (p. 523).*	Motivation, confidence, physical competence, knowledge, valuing, responsibility, PA, awareness for moral behavior & connection with others	Children and adolescents
18	IPLA	2017	Global	Holistic	General	*Physical literacy is the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life (p. 1)*	Motivation, confidence, physical competence, knowledge, valuing, responsibility, PA	Unspecified

(table cont'd.)

#	Author	Year	Origin	Approach	Setting	Definitions	Elements	Population
19	Tremblay, Costas-Bradstreet et al.	2018	Canada	Holistic	Youth Sport	*Physical literacy is the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life (p. 16)*	Motivation, confidence, physical competence, knowledge, valuing, responsibility, PA	Unspecified
20	PHE Canada	n.d.-b	Canada	Holistic	General	*Physical literacy is a journey upon which children and youth, and everyone, develop the knowledge, skills, and attitudes they need to enable them to participate in a wide variety of activities.*	Knowledge, skills, attitudes and PA	Children, youth, and everyone
21	SHAPE America	n.d.	U.S.	Performance-Driven	PE	*The ability to move with competence and confidence in a wide variety of physical activities in multiple environments that benefit the healthy development of the whole person.*	Competence, confidence, PA	Lifespan
Summary		**1969 to 2018**	**> 3**	**3**	**3**	**16 (overlapped definitions adjusted)**	**20 elements (overlap-adjusted)**	**Ages across lifespan**

Note. DCMS: Department for Digital, Culture, Media and Sport; FMS: Fundamental motor skills; IPLA: International Physical Literacy Association; PHE: Physical and Health Education; SHAPE: Society of Health and Physical Educators; UNESCO: The United Nations Educational, Scientific and Cultural Organization.

Philosophical underpinnings. Monism, existentialism, and phenomenology are the three most recognized philosophical underpinnings for the concept of PL. Monism is in opposition to the Cartesian dualism (i.e., mind and body as interdependent entities rather than independent parts). This ideology views the self as a consciously and bodily integrated whole (Whitehead, 1993, 2001). With such an integrated self that enables movements with thoughts and feelings through body, one can experience through proximate surroundings and then get embodied. An enriched embodiment through fluent interaction with the external world shapes a progressively developing individual. As this individual accumulates more through exchanges with outside world, personal capital is stored for future life even if it is challenging. Thus, whenever we want to make changes to ourselves such as receiving education, we need to proactively interact with the world to fulfill the change (i.e., listening, reading, or practicing skills till motor automation). The more we can interact with the world, the more we can be developed. This is in line with the tenet of existentialism that the formation of self is based on interaction with external world (Whitehead, 2001); and such an interaction varies if environment changes. Commonly, the environment is always changing regardless of presence or absence of self. This creates the possibility that each person's interaction with the world is experienced uniquely and so does the self-development. Past experiences decide how we view the world now from a unique perspective (Husserl, 1991; Whitehead, 2010). The uniqueness of our understanding and perspective in thinking through accumulated past experiences is termed as phenomenology.

The degree to which we can interact with the world to the interest of self is called capability, and increased capability is often accompanied strengthening of confidence. According to Whitehead (2001), PL should involve more than physical competence, but also the capability to perceive intelligently and respond appropriately in relation to the environment. Perceiving

intelligently can be interpreted as observing and/or receiving critically and purposefully which further refers to gaining knowledge and skills in need as well as analyzing information by proper reasoning (i.e., cognitive and physical capability development; Pot, Whitehead, & Durden-Myers, 2018; Whitehead, 2001). The effective responding may be interpreted as fulfilling an interaction with world or the application of an appropriate response based on external stimuli (Whitehead, 2001), such as performing a series of movements using varieties of skills or launching attack in cooperative effort with teammates. From this perspective, every personal property in mind and body is initialized through interaction with environments rather than the inbuilt. Literally, a physically literate individual is developed via "perception, experience, memory, anticipation and decision making" (i.e., interactive process) to gain movement capacity (i.e., moving with poise, economy and confidence), overcome physically challenging situations (i.e., competent in taking various physical challenge) and respond to environments (i.e., sufficiently receive, analyze and interpret surroundings and make appropriate decisions; Allan, Turnnidge, & Côté., 2017; Whitehead, 2001, p. 131).

From another perspective, the overarching goal of PL is lifelong physical activity participation, which is purely behavior-oriented. To this end, debate has been long carried out as to whether PL is measurable (Chen, 2020). While Whitehead's publications have never mentioned about PL measurement, her philosophy towards PL was methodologically approximated to the *phronesis*. Phronesis centers on one's unique experience, embodiment, conception, then to values and reasoning for behaviors (e.g., regular exercise for health; Kosma, Buchanan, & Hondzinski, 2015). Typically, the phronetic approach research/program assists to foster one's own understanding and interpretation that helps people to autonomously develop practical skills (Kosma et al., 2015). This *praxis* approach acknowledges that human actions are

not following exactly the same law as naturality (i.e., cause-and-effect pathway), but the moral reasoning. Moral reasoning means a process of making appropriate decisions through logical identification. So, measuring constructs underpinned by a PL-predictive framework should not be desirable to reflect people's behavior (e.g., lifelong physical activity engagement). And praxis opposes using intervention in behavior change. Contrary to praxis is theoria where understanding human behaviors is feasible through priori knowledge (Kosma et al., 2015). PL instruments were developed to measure PL through this philosophical perspective (e.g., Lodewyk, & Mandigo, 2017).

The priorities of PL in PE. After the release of the new national PE standards, several research journals have published collections of papers in special issues. In these special issues papers, researchers shared their unique perspectives on the priorities of developing physically literate individuals. In a nutshell, some researchers believed the development of a physically literate person should be prioritized in ample physical activity (Lounsbery & McKenzie, 2015) and motor skill competency (Silverman & Mercier, 2015; The Aspen Institute, 2015a, 2015b). They thought the use of the term "physically literate" instead of "physically educated" individuals as the outcome of PE shifts the valuing of PE outcome from the psychomotor-oriented to the cognitive-oriented, which derails the conventional track of physical activity and motor skill development and even leads to the extinction for PE "as a standard part of the U.S. K-12 education curriculum" (Lounsbery & McKenzie, 2015, p. 139). Physical literacy involved in this camp would be "the ability, confidence, and desire to be physically active for life" (The Aspen Institute, 2015a, p. 9).

While the central role of fundamental motor skill (FMS) in PE was questioned (Almond, 2014), other researchers believed the priority of PL development should be knowledge and

understanding (including knowledge possession, transmission, transfer and innovation) about fitness and physical activity (Ennis, 2015; Mandigo et al., 2009) and movement creativity (Mandigo et al., 2009; Penney & Chandler, 2000) which involves capability of cognitive processing. Additionally, motivation as an integral aspect of PL should also be valued in PE because motivation is a manipulative internal disposition that can be acquired through quality PE (Chen, 2015). However, despite the divergent perspectives on how to develop PL through PE, priorities should not be taken at the expense of jeopardizing the balance across affective, physical, cognitive, and behavioral factors (Tremblay, Costas-Bradstreet, et al., 2018; The Aspen Institute, 2015a, 2015b) or the mind-and-body integration (Whitehead, 2001).

Settings for PL development: PE versus youth sport program. PL can be fostered both in school PE programs and through youth sport (Castelli, Barcelona, & Bryant, 2015; Edwards, Bryant, Keegan, Morgan, & Jones, 2017; Lundvall, 2015; Sum, Wallhead, Ha, & Sit, 2018), or even in other settings (Castelli, Centeio, Beighle, Carson, & Nicksic, 2014). PE and sport "do not always share the same goals or serve the same individuals," thus, "a definition of PL that is relevant to and representative of the educational environment" is expected (Mandigo et al., 2009, p. 5). Existing PLs defined for different settings did vary (DCMS/Strategy Unit, 2002; Higgs et al., 2008; Mandigo et al., 2009; SHAPE America, 2014). PL in sports has a lot to do with a wide range of motor skills developments; while PL in PE targets knowledge and skills acquisition and their applications (Mandigo et al., 2009). In this sense, an overarching PL definition compromising its use for both scenarios was created accordingly (Mandigo et al., 2009). A study that surveyed 12 globally selected experts to share their definitions of PL revealed that the core principle of PL should be "the ability to capitalize on the interaction between physical competence and affective characteristics" (Mandigo et al., 2009, p. 28), which

provides guideline to bridge the gap between PE and youth sport. Also, Sport and PE are not absolutely isolated; it was believed that by fostering fun and enjoyable sport experiences, students and athletes can gain knowledge, competence, and attitudes as the foundation of PL for the long-term retention of participation, performance, and personal development (Vierimaa, 2016), which are essential for lifelong physical activity engagement (Allan et al., 2017).

Divergent strategies for PL development. PL development can be viewed from two distinct approaches: the holistic approach and the performance-driven approach (Allan et al., 2017). The holistic approach is advocated by Whitehead who believes that PL promotion should de-emphasize intensive focus on motor skill competency and immediate fitness rewards / achievements and instead should emphasize fostering embodied competence and positive attitude towards healthy and active lifestyle by respecting individual uniqueness (Allan et al., 2017; Whitehead, 2007). In comparison, the performance-driven approach emphasizes physical skills and/or fitness development to build competence. Each approach bears limitations as to PL development. For example, early engagement in specified sport programs leads to burnout or dropout that jeopardizes long-term physical activity participation (Allan et al., 2017; Almond, 2014; Fraser-Thomas, Côté, & Deakin, 2005), but merely focusing on individualized and balanced development may hinders one's potential to pursue high levels of sports achievement in a later developmental stage (Côté & Fraser-Thomas, 2016). To strike a balance between the two approaches, Allan et al. (2017) defines PL with an integrative/balanced approach as having (a) "the motivation, confidence, physical competence, knowledge and understanding to value and take responsibility for engagement in physical activities for life;" and (b) having "a self-awareness that encourages moral behavior and meaningful connections with others in physical activity contexts" (Allan et al., 2017, p. 9).

Despite the varying definitions of PL, the fundamental goal of PL development is to achieve an active lifestyle in the entire lifespan. To achieve this goal, fostering strategies may not be always the same. According to Longmuir and Tremblay (2016), the PL journey is under the influence of intrapersonal and environmental factors. The PL journey would vary across individuals who are living in a unique setting. For example, some people may be active simply because of enjoying a sport; while others are active because they hope to lower risks of chronic diseases. There is no one single pathway towards lifelong physical activity participation.

PL Components

The principal differences in PL definitions lie in the different compositions of components stressed in these definitions (as shown in Table A.2.). Currently, there are burgeoning publications shooting for what should be the PL components. However, studies specifically addressing this topic applied different perspectives; and thus, led to a diverse conclusion for the PL components. For instance, what are the commonly identified components of PL were discussed by Corbin (2016) who eventually came up with 11 components. Edwards et al. (2017) extracted 37 categories based on 694 codes about the aspects of PL; and most categories at intrapersonal level can be considered the related PL components. Mandigo et al. (2009) pointed out that the process of developing physically literate individuals should involve 11 steps, with each step being able to represent an integral part/component of PL (Mandigo et al., 2009). McClelland (2013) contended that the components for PL should reflect the attributes of mind and body integrated individual (McClelland, 2013). Similar idea was for Allan et al. (2017) who further depicted six essential components of PL working for positive youth development: knowledge and attitudes, physical activity behaviors, competency, connection, confidence, and character (Allan et al., 2017). The Aspen Institute version has less PL components (ability,

confidence, and desire) outlined and one goal (i.e., lifelong active lifestyle), in which "ability" refers to "competency in basic movement skills" and overall fitness (i.e., physical domain), "confidence" means knowing the ability to participation (i.e., affective domain), and "desire" represents intrinsic enthusiasm (i.e., affective domain; The Aspen Institute, 2015b). While it satisfies two domains, cognitive aspect such as learning knowledge and understanding health benefits is missing. Similar definitions unilaterally focusing on aspects of physical developments are those from organizations such as UK Sport, PHE Canada, and Sport for Life Society.

Table A.2. Physical Literacy Components as Articulated in Notable Existing Publications

Authors (year)	**PL Components**	**Explanation**
Corbin (2016)	1) Cognitive skills; 2) Confidence; 3) Interaction with others; 4) Motivation; 5) Motor skills; 6) Perception of environment; 7) Physical activity; 8) Physical fitness; 9) Responsibility for engagement for life; 10) Responsibility; 11) Values in physical activity.	Characteristics most commonly associated with physical literacy.
Edwards et al. (2017)	1) Confidence (26); 2) Develop whole person (15); 3) Human disposition (8); 4) Knowledge and understanding of activities (16); 5) Motivation (23); 6) Movement with poise and economy (5); 7) Physical activity (22); 8) Physical competence (12); 9) Purposeful physical pursuits (6); 10) Read/interact with environment (14); 11) Throughout the lifespan (19); 12) Unique journey (7); 13) Value and take responsibility for physical activity (2).	Part of the 37 core categories based on 694 codes with the parenthesized number representing the number of papers that referred to; only PL related components are listed.

(table cont'd.)

Authors (year)	PL Components	Explanation
Hyndman and Pill (2017)	1) Activity; 2) Competence; 3) Concept; 4) Fitness; 5) Health; 6) Role; 7) Understanding.	Most frequently studied aspects associated with PL based on 49 identified literature.
Mandigo et al. (2009)	1) Beneficial to and respectful of themselves, others and their environment; 2) Confidence and competence; 3) Creativity (e.g., applying skills in new and novel environments); 4) Diverse forms of movement; 5) Health-related fitness; 6) Healthy active choice; 7) Lifespan healthy behaviors and PA participation; 8) Motivation; 9) Strategic thinking; 10) Understanding, communication, application and analysis.	The process of becoming the physically literate.
McClelland (2013)	1) Confidence and physical competence; 2) Interaction with environment; 3) Knowledge and understanding; 4) Motivation; 5) Self-expression and communication with others; 6) Sense of self and self-confidence.	Synergy of attributes of the mind and body integrated person.
Patriksson & Persson (2013)	1) Competence; 2) Environment; 3) Expression & Interaction; 4) Knowledge and understanding; 5) Motivation; 6) Sense of the self.	Dimensions of PL summarized based on Whitehead (2010).
Dudley (2015)	1) Motivation and behavioral skills of movements; 2) Movement competencies; 3) Personal and social attributes of movement; 4) Rules, tactics, and strategies of movement.	Principal elements described in observed PL model.

(table cont'd.)

Authors (year)	PL Components	Explanation
Allan et al. (2017)	1) Character; 2) Competence (physical fitness; technical, tactical and motor skills); 3) Confidence; 4) Connection; 5) Knowledge and attitudes; 6) Physical activity behavior.	Specified constructs that can be manipulated to support integrated approach to PL.

Note. PL: physical literacy.

Table A.3. Cross-Tabulation of Physical Literacy Definitions (N = 21) by Setting and Approach

Setting	Approach		
	Holistic Approach	*Performance-driven Approach*	*Integrated Approach*
Physical Education	1	2	0
Youth Sport Programs	2	8	1
General	7	0	0

Note. Numbers in table represent counts of definitions**.**

Since the specific components integral to PL are different across the definitions, seeking common grounds is worth trying. Beginning from 2001, the concept of PL was framed with the anti-dualism philosophical backdrop, which advocated the "body and mind to be an integrated whole" (Whitehead, 2001). For each individual, being as a self is the result of interaction with surroundings and the embodied experiences (i.e., existentialism and phenomenologist). Whitehead argued that "being able to do" or accomplishing mastery of physical competence (e.g., muscle strength and joint flexibility) does not necessarily represent achievement of PL unless the person is "able to perceive intelligently and respond appropriately" (Whitehead, 2001, p. 130). Following this thread of thought, PL is not a "purely capacities" but a "holistic engagement" that incorporates "perception, experience, memory, anticipation and decision making" (Whitehead, 2001, p. 131). This five-element framework should be the philosophical guidance to theorize the essential components of PL.

General PL Definition

In 2015, five Canadian organizations and the IPLA have reached a multilateral agreement on a PL definition that allegedly can be used interchangeably among different settings (e.g., PE, physical activity, and youth sport; The Aspen Institute, 2015a, 2015b; Tremblay, Costas-Bradstreet, et al., 2018). This definition confines all its descriptive components in affective, cognitive, physical, and behavioral domains. However, synthesizing such an overarching PL definition has more virtue for academia than for other purposes. In general, the four domains by Canadian Sport for Life (Tremblay, Costas-Bradstreet et al., 2018) embrace almost all components extracted from the existing 21 PL definitions, except for responsibility (see Table A.1. and Table A.4.). It also skipped the philosophical essence proposed by Whitehead, the founder of modern PL, focusing instead only on more measurably workable dimensions from a pragmatic perspective. With a collateral brainstorming among all the authors, we define PL as: A state of being physically cultured for lifelong active lifestyles enabled by embodied possessions and moral reasoning through cognitive, affective, physical, and behavioral developments and their interplays. It is a dynamic journey to its ultimate goal of engaging in lifelong physical activity, and thus should be evaluated cumulatively at different time points across entire lifespan. Our version of PL covers both pragmatic and philosophical aspects of PL and embraces more thinking in between theoria and praxis in reasoning the relationships among PL measurement, evaluation, development, and manipulation.

Table A.4. A Summary of the Physical Literacy Components by Setting and Approach

Category	Sub-Category	PL Components
Setting	**PE**	*Affective domain*: Motivation; Confidence. *Physical domain*: Skillfulness; Competence. *Cognitive domain*: Creativity; Imagination; Knowledge. *Behavioral domain*: PA.
	Youth Sport Program	*Affective domain*: Confidence; Motivation; Desire; Enjoyment; Responsibility. *Physical domain*: Competence; Ability to "respond"; Physical competence portions (including agility, balance, coordination, FMS, and control); Skillfulness; Ability. *Cognitive domain*: Ability to "read"; Knowledge; Understanding; Decision making; Valuing. *Behavioral domain*: PA.
	General	*Affective domain*: Competence; Confidence; Motivation; Attitude; Responsibility. *Physical domain*: Ability to "respond"; Physical competence (FMS, control); Skillfulness; Ability. *Cognitive domain*: Ability to "read"; Knowledge; Valuing. *Behavioral domain*: PA.
Approach	**Holistic approach**	*Affective domain*: Competence; Confidence; Motivation; Attitude; Responsibility. *Physical domain*: Ability to "respond"; Physical competence (or its portion); Ability. *Cognitive domain*: Ability to "read"; Knowledge; Valuing. *Behavioral domain*: PA.
	Performance-driven approach	*Affective domain*: Confidence; Motivation; Enjoyment; Responsibility. *Physical domain*: Competence; Skillfulness; Ability to "respond"; Physical competence portions (including agility, balance, coordination, skill, FMS, sport/physical skill, control); Ability. *Cognitive domain:* Creativity; Imagination; Ability to "read"; Knowledge; Understanding; Decision making. *Behavioral domain*: PA.

Note. FMS: fundamental motor skills; PA: physical activity; PE: physical education; PL: physical literacy.

PL: More conceptual than definitive. The greater concern to field experts of PL is how to properly define PL. Empirical researchers usually hold strong beliefs that an unmeasurable variable has little worth of scientific investigation. This leads to a unanimous desire to set up the

boundaries for what PL really is, as an initial step toward proper measurement of PL. This is perhaps why over the years researchers have attempted to outline PL and then create tools to assess PL and PL domain/components described as aforementioned. However, the term "physical" and "literacy" of PL is a composite that wraps literacy with a cocoon of "physical". While each vocabulary of the term "physical literacy" has a broad and vague meaning *per se*, the amalgamated term "physical literacy" can be even vaster in literally defining it (Wallis, 2015). Given that, a conclusive interpretation of PL should be more realistic to be defined within specified settings (see Figure A.1). Without contextualization, PL is merely a continuum or vision of limitless/infinitive possibilities that points to a concept (Otte & de Barros, 2016). For practitioners (e.g., a physical educator or a sport coach), a setting-specified PL definition works better than an overarching one as a guidance for clarifying implementation centralities. The requirements and achievements of students in PE course versus athletes in youth sport programs are in part different in spite of the shared commonalities. This leads to the need to categorize PL by setting and approach that better prioritize the goals and desirable outcomes from each setting, as shown in Table A.1., Table A.3. and Table A.4..

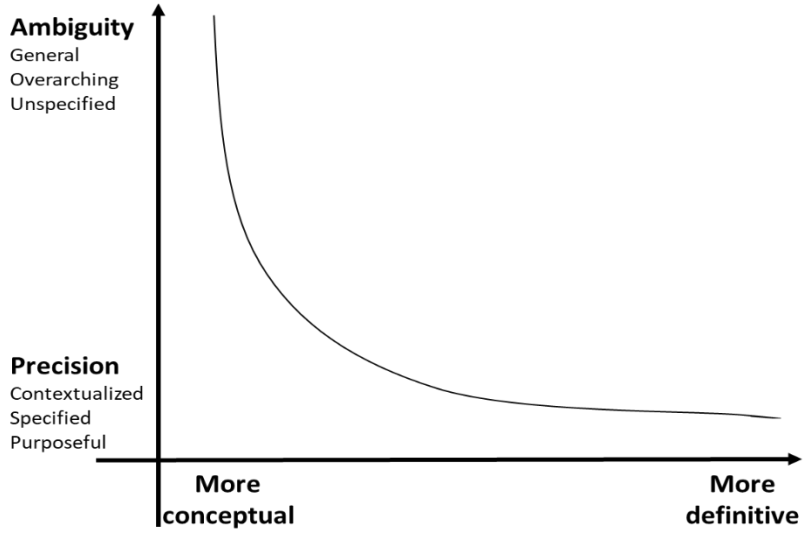


Figure A.1. Relationship between Concept and Definition

Characteristics in general PL definition. As shown in Table 1., most identified PL definitions have their uniqueness that can be specifically assigned to name their category and differentiate itself from other definitions. Based on my investigations, all 21 PL definitions are embedded in a certain approach or context (i.e., holistic vs. performance-driven approaches; PE vs. youth sports vs. general settings; see Table 1.), and have specific regularities in the categorization (see Table 3. and Table 4.). For example, PL definitions contextualized in youth sports and PE are dominated by the performance-driven approach (more measurable); and PL definitions used for general purposes are mostly labeled by the holistic approach, which is often philosophical and immeasurable (Allan et al., 2017). However, only one existing definition fits the eclectic approach that balances the holistic and performance-driven approaches (Allan et al., 2017). The above analysis indicates the need for operationalization of PL in real contexts. Also, PL as a lifelong journey should adopt an incremental approach that promotes and sustains progress at different developmental stages or grade levels. The footage on which each PL step places can be viewed as a temporary indicator reflecting achievement alongside the PL journey. In addition to acknowledging the importance of PL achievement at a specific time point, evidence has shown extended longitudinal benefits of early age PL achievement for adulthood. For example, FMS and physical activity as PL components at a young age are likely to predict physical activity behavior at adulthood (Holfelder & Schott, 2014). This is why formative progress matters to the development of PL. Finally, the 21 PL definitions have more similarities than differences. All the constituency components of each definition are affiliated to one of the four basic domains of the overarching PL definition: physical, behavioral, cognitive, and affective (Tremblay, Costas-Bradstreet, et al., 2018; The Aspen Institute, 2015a, 2015b).

Assessments of PL

Assessment is considered as one of three primary themes in PL research (Lundvall, 2015). There is a variety of instruments assessing PL and/or PL components. The existing assessments developed mostly by Canadian organizations and scholars include but not limited to the Physical Literacy Assessment for Youth or PLAY (Sport for Life Society, n.d.), Physical Literacy Observation Tool or PLOT (Early Years Physical Literacy Research Team, n.d.), PHE Canada - Passport for Life (PHE Canada, n.d.-a), and Canadian Assessment of Physical Literacy (CAPL; Healthy Active Living and Obesity Research Group [HALO], 2017a). Additional instruments are available measuring FMS such as 60 Minutes Kids Club (60 MKC) PL assessment tool (Jupiter[4], n.d.; Personal Sport Record, n.d.) and Perceived Physical Literacy Inventory (Sum et al., 2016). In the U.S., SHAPE America has endorsed certain instruments to measure PL components, such as the FitnessGram for health-related fitness assessment (Welk, De Saint-Maurice Maduro, Laurson, & Brown, 2011; Welk & Meredith, 2010) and the PE Metrics for standards attainment (Dyson et al., 2011; National Association for Sport and Physical Education [NASPE], 2010, 2011). The PL related assessments documented in the existing literature are synthesized below by assessed components, targeted users, and scoring methods.

Table A.5. Summary and Analysis of the Existing Physical Literacy Assessment Tools

Name	Year	Developer	Population	Domains	Approach	Scoring	Time	Strength	Limitation
Physical literacy assessment for youth (PLAY)	2009	University of Manitoba and released by Sport for Life Society	Children aged (seven yr old or above)	Cognitive; affective; physical competence; and participation in various environment.	By PE specialist /coach; self-report; parents	No overall score to PL; separate score to each PL component	Long	Research and program evaluation; assess multiple PL components; free; applicable in multiple contexts; may assess in groups of two+	Does not include measures for physical activity and fitness
Canadian Assessment of Physical Literacy (CAPL)	2014	Healthy Active Living and Obesity Research Group	eight - 12 years old	Physical competence; knowledge and understanding; motivation; and Confidence	By Coaches or PE teachers	Composite PL score and separate scores for component; (beginning, progressing, achieving and exceling)	30 – 45 min except for daily steps	Comprehensive testing for PL; Population surveillance tool; scores of components were weighted for overall PL	Misleading in interpreting overall PL score (low knowledge equals to low competency)

(table cont'd.)

Name	Year	Developer	Population	Domains	Approach	Scoring	Time	Strength	Limitation
Physical Literacy Observation Tool (PLOT)	n.d.	Early Years Physical Literacy Research Team	Early-year children (preschoolers)	FMS	Parents and early children education practitioners	Reflective feedback	NA	Easy to handle (observing and referring)	Only focus on FMS
Physical and Health Education (PHE) Canada - Passport for Life	2013	PHE Canada	third - 12th grade	Active participation; living skills; fitness skills; movement skills	By generalists or PE specialists	Four-level scale; two rounds of measurement per school year; assessed using self-report and observation	Long	Formative assessment; for individual / class as a whole; free; assessments as reflective feedback to determine strategies for PL promotion; older students can help the assessment	Not summative assessment; unsuitable for research; not for assessing PL but PL-based curriculum; three teachers for assessment
PL tools endorsed by SHAPE America	2011	Cooper Institute; NASPE	3rd- 12th grade	Motor skills; knowledge; physical activity; physical fitness; motivation	PE specialists, program staffs or trained researchers	No overall PL but separate scores	Long	High validity and reliability	Not all PL domains are covered

(table cont'd.)

Name	Year	Developer	Population	Domains	Approach	Scoring	Time	Strength	Limitation
60 Minutes Kids Club (60 MKC) PL Assessment Tool	NA	Matt Young sponsored by Innovative Fitness & TELUS	five to 12 years old	FMS; physical activity; sedentary behavior	Generalists, parents, coaches or caregivers	Four-level scale (emerging, developing, acquired and accomplished)	30 mins	Free; can be organized in unit of class, team or even school; captures skills progress; easy to handle; age specific (three – five, five – eight, and eight - 12); official assessment and self-assessment	Only focused on FMS and physical activity and sedentary behavior; can only be used in school context
Perceived Physical Literacy Inventory	2016 & 2018	Sum et al.	11 to 19 years old; and adults (e.g., PE specialists)	Knowledge and understanding; self-expression and communication with others; sense of self and self-confidence	Self-report	Measured using nine items on five-point Likert scale; score for each sub scale	eight-10 mins	Valid and reliable; easy to handle	Not covering all PL component; PL components unweighted; for assessing Asians

Note. NASPE: National Association for Sport and Physical Education; PL: physical literacy; FMS: fundamental motor skills; SHAPE: Society of Health and Physical Educators; TELUS: Telus Corporation.

Assessed components. Because different definitions of PL usually have different components, the assessment of PL also varies. The assessed components for SHAPE America and CAPL are highly similar. SHAPE America's definition of PL includes components such as motor skills, knowledge, physical activity, physical fitness, and student motivation (Dudley, 2015; Hastie, 2017). It has endorsed several instruments to measure K-12 students' attainment of the five standards (SHAPE America, 2014), including FitnessGram (Plowman & Meredith, 2013; Plowman et al., 2006; Welk et al., 2011; Welk & Meredith, 2010) and the PE Metrics (NASPE, 2010, 2011). For CAPL, four components are delineated to represent and assess PL including knowledge and understanding, physical competency, daily physical behavior, motivation and confidence (HALO, 2017a). The PLAY tools have three components including cognitive, motor competence, and environment (Sport for Life Society, n.d.). A series of PLAY tools are available to assess PL. For example, PLAY*fun* is used for the comprehensive assessment of the three components, while PLAY*basic* is a shortened and simplified version of PLAY*fun* (Sport for Life Society, n.d.). There are also some other tools developed for specific users such as parent (PLAY*parent*), coach (PLAY*coach*) and youth (PLAY*self*; Sport for Life Society, n.d.). The PLOT evaluates early children's PL on one single component, the FMSs (including stability skills, manipulative skills, and locomotor skills; Early Years Physical Literacy Research Team, n.d.); and the same for 60 MKC PL assessment tool (Jupiter[4], n.d.; Personal Sport Record, n.d.). Lastly, Passport for Life is an online PL measurement tool for parents, children, and PE teachers including four assessing components: active participation (i.e., assessing the application of PL through a variety of physical activity behaviors and diverse environments), living skills (i.e., assessing awareness, skills of physical activity behaviors, and motivations associated with making healthy active choices, etc.), fitness skills (i.e., assessing

balance [lateral bound], core strength [plank], and cardiovascular endurance [four station circuit]), and movement skills (i.e., assessing FMS such as object manipulation, object control, and locomotion; PHE Canada, n.d.-a).

Targeted users. I sort out for whom the assessment tools are developed for (i.e., the examinees) and who the users of the instruments are (e.g., coach, PE teacher, and parents). Through literature review, I found that the tools endorsed by SHAPE America have no fixed users and can be used by PE practitioners, program staffs, or trained researchers. The PE Metrics can be used for elementary and secondary school students (NASPE, 2010, 2011); and FitnessGram is used for children and adolescents from third grade to 12th grade (Plowman & Meredith, 2013; Plowman et al., 2006; Welk et al., 2011; Welk & Meredith, 2010). CAPL was developed for assessing children aged between eight to 12 years old and the appraisers can be coaches or teachers (HALO, 2017a). PLAY was developed for children of ages seven or above, and can be used by students themselves, coaches/teachers, or parents (Sport for Life Society, n.d.). PLOT was developed for early-year children (i.e., infants, toddlers, and preschoolers) and was used by parents and early children education (ECE) practitioners as observers (Early Years Physical Literacy Research Team, n.d.). Finally, the intended users of Passport for Life are teachers, parents, and students themselves (PHE Canada, n.d.-a). It is a user free PL assessment tool for PE specialists, parents, and students currently available for fourth to 12th graders (assessment tool for grade three is in developing).

Scoring methods. The approaches to quantifying PL also differ across the assessment instruments (e.g., assigning one general score to a PL level vs. using score for individual PL components). SHAPE America does not have a scoring system for quantifying the overall PL level, although the PE Metrics was originally designed to produce a single overall score upon

mathematical equating and standardization. The PE Metrics does not assess all five standards and the single standardized score has rarely been used by researchers and practitioners (NASPE, 2010, 2011). CAPL has separate scores available for each component/domain and an overall score for the four domains combined (HALO, 2017a). PLAY does not have an overall PL score, but it has scores for each component (questions on a 4-point scale: zero = low to three = high; Sport for Life Society, n.d.). PLOT does not have a criterion for levels of PL but it has a reference chart for users to receive reflective feedback. The Passport for Life does not provide a composite score quantifying PL or a separate score for each assessment component; however, a Passport report with separate assessment results (either for a single student or for a class as a whole) is available to each PL assessment component (PHE Canada, n.d.-a). The students will have to report on-line their active participation and living skills with four-level scale (i.e., never, sometimes, most of the time, and all of the time); while the teachers will observe and assess their fitness skills and movement skills using a rubric (i.e., for both skill assessments: emerging, developing, acquired, and accomplished) and a recording form. There is only informational result for students' active participation, and an aggregated level will be assigned to each of the rest three components.

Performance-driven vs. holistic approaches. The assessment for the performance-driven approach of PL is much more plural than the holistic approach, as the former is primarily focused on sport/FMSs that are relatively easy to measure at a specific time point (Allan et al., 2017). For instance, the Passport for Life is an instrument to evaluate students' physical activity participation, fundamental movement skills, and fitness; the 60-Minute Kids Club Fundamental Movement Skills Assessment tool assesses students' motor competency; and Canadian Sport for Life PLAY tools are measurement kits designed for evaluating students' competence,

confidence, and activities. Giblin, Collins, and Button (2014) also provided a guidance for PL movement assessment involving types of skills, skills descriptions, and evaluation of skill learning. The measurement of PL following the holistic approach is rare, because this approach views PL as unmeasurable (Allan et al., 2017). In addition, several assessment tools are available to separately measure the essential constructs of the eclectic approach (Allan et al., 2017): 1) physical activity behaviors (measured using self-reported questionnaire, pedometers and/or accelerometers along with daily physical activity log sheets; Allan et al., 2017; Colley, Connor Gorber, & Tremblay, 2010; Eisenmann, Laurson, Wickel, Gentile, & Walsh, 2007; Francis et al., 2016; Tremblay & Lloyd, 2010; Tudor-Locke, McClain, Hart, Sisson, & Washington, 2009); 2) knowledge and attitudes (measured using questionnaire for knowledge and understanding assessment; Allan et al., 2017; Francis et al., 2016; Gunnell, Longmuir, Barnes, Bélanger, & Tremblay, 2018; Longmuir, Woodruff, Boyer, Lloyd, & Tremblay, 2018; Tremblay & Lloyd, 2010); 3) competence (measured using anthropometric and performance tests; Allan et al., 2017; Francis et al., 2016; Longmuir et al., 2017; Tremblay & Lloyd, 2010; Welk & Meredith, 2010); 4) confidence (measured using self-confidence subscale of the Revised Competitive State Anxiety-2; Allan et al., 2017; Cox, Martens, & Russell, 2003; Gunnell, Longmuir, Barnes et al., 2018); 5) connection (measured using Coach-Athlete Relationship Questionnaire and the Peer Connection Inventory; Allan et al., 2017; Jowett & Ntoumanis, 2004; Vierimaa, Erickson, Côté, & Gilbert, 2012), and 6) character (e.g., Prosocial and Antisocial Behavior in Sport Scale; Allan et al., 2017; Kavussanu & Boardley, 2009; Kavussanu, Seal, & Phillips, 2006).

Conclusions

The development of PL is a *means to an end* as well as *an end* itself. As *a means*, the cultivation of PL has is to ultimately promote and sustain lifelong physical activity participation

(Whitehead, 2013a, 2013b), which should start at an early age (Castelli et al., 2015) in settings such as PE classes (Giblin et al., 2014) and/or youth sport programs (Allan et al., 2017). However, the linkage between PL achievement and lifespan physical activity behavior is still elusive and warrants longitudinal research. The scholarship on PL appears to be chaotic, largely due to the inconsistent definitions and assessments of PL. According to IPLA, PL involves six conceptual components and the associations of these components with physical activity participation have been justified by sporadic evidence in prior research. For example, motivation (Hartmann, Dohle, & Siegrist, 2015), confidence (Brassington, Atienza, Perczek, DiLorenzo, & King, 2002), physical competence (Springer, Lamborn, & Pollard, 2013; Wasserkampf et al., 2014), physical activity behavior at young age (Telama et al., 2014), knowledge (Chen, Liu, & Schaben, 2017; DiLorenzo, Stucky-Ropp, Vander Wal, & Gotham, 1998; Thompson & Hannon, 2012), and understanding to the values of physical activity (Müller-Riemenschneider, Reinhold, Nocon, & Willich, 2008) have shown statistically significant associations with physical activity. Meta-analysis also has shown FMS (element in physical competence) as a precursor of physical activity level (Holfelder & Schott, 2014). As *an end*, however, PL is a meaningful educational outcome that all physical educators in K-12 and coaches in youth sports programs should strive to teach youth to experience, learn, and progress through deliberately designed PL-promoting curricula, instruction, and coaching. Sorting out the definitions of PL and its essential components is significant in guiding future scholarship and practice to understand, study, and promote PL in schools and after-school settings. Synthesizing the existing scholarship on PL assessment is also fundamental for future researchers and practitioners to accurately and conveniently assess PL for a variety of purposes such as diagnosis, learning assessment, and program evaluation.

Paper Two

The concept of physical literacy (PL) has been recently revived in applied contexts such as physical education and youth sport. It is believed that improvements in PL and its components are beneficial to well-being. The purpose of this article was to summarize existing scholarship on intervention studies or programs related to PL. A thorough literature review was conducted by following three methodological steps. Article entries that met the inclusion criteria were downloaded, extracted, organized, coded, and synthesized for literature synthesis. Four themes were discussed: (1) interventions for developing PL, (2) interventions for developing constituency components of PL, (3) PL-related interventions for physical activity promotion, and (4) achievements of PL and its components by gender and age. The findings of this article provide guidance on how to foster *physically literate* students.

Introduction

Physical literacy (PL) has become a globally heated topic in recent years. Each year, new progress is being made to advance research, practice, and policy related to PL. In the United States (U.S.), the latest national physical education (PE) standards have been revised to foster the *physically literate individuals* (Society of Health and Physical Educators [SHAPE] America, 2014). In Canada, PL achievement is represented by fostering the holistic mind-to-body integrated students that demonstrate competencies in four interconnected domains: physical, cognitive, affective, and behavior domains (Tremblay, Costas-Bradstreet, et al., 2018; SHAPE America, 2014). Clearly, development of PL has become an important educational goal and outcome of PE. In addition, PL development has also been regarded as *a means to an end* (Longmuir & Tremblay, 2016). That is, experts have reached a consensus that the ultimate goal of PL is lifelong physical activity participation (Tremblay, Costas-Bradstreet, et al., 2018; Whitehead, 2010). Epidemiology

research has shown that almost all patterns (e.g., sporadic, bouts, and continuous) of physical activity are beneficial to the physical, psycho-social, and cognitive health among children and adolescents (Donnelly et al., 2016; Poitras et al., 2016). However, physical activity casts a declining trend across age in both boys and girls (Dumith, Gigante, Domingues, & Kohl, 2011; Nader, Bradley, Houts, McRitchie, & O'Brien, 2008) with only around 16.3-20.0% of the youth population meeting the physical activity guidelines (Hallal et al., 2012; Song, Carroll, & Fulton, 2013). PE and youth sport programs are viewed as the main settings to develop PL (Tremblay & Lloyd, 2010) and to promote youth physical activity. Empirical evidences on how to develop PL and its related components among K-12 learners, both as a process and an outcome, are burgeoning and these studies need to be systematically sorted out and synthesized (Cairney, Bedard, Dudley, & Kriellaars, 2016; Hastie, Chen, & Guarino, 2017; Hastie & Wallhead, 2015). The purpose of this literature review was to summarize and synthesize the existing research on PL interventions.

To date, researchers and practitioners have put forth concerted effort to promote learners' achievement of PL (Hastie et al., 2017; Hastie & Wallhead, 2015). However, my recent literature review identified 16 different definitions of PL as documented in the existing literature (see my paper one in Appendix). These definitions originated from scholars and organizations that held various theoretical/practical perspectives. For example, Dr. Margaret Whitehead defined the *physically literate* as individuals who "move with poise, economy and confidence in a wide variety of physically challenging situations" (Whitehead, 2001, p. 131). Motor behavior experts, in contrast, regard physically literate individuals as those who possess sufficient fundamental motor skills (FMS; Sheehan & Katz, 2010; Sheehan, Van Wyk, Johnson, & Blanch, 2016; Silverman & Mercier, 2015; The Aspen Institute, 2015a, 2015b). No consensus has been reached across scholars

and professional organizations on what PL is. Due to the variations of PL definitions and inconsistent beliefs on what PL is or what it should be composed of (e.g., knowledge, physical competence, motivation, physical activity behavior, etc.), the method to assess PL and its components also appears to vary across studies and theoretical perspectives, ranging from assessing PL as one single overarching construct to assessing individual PL components such as FMS (Giblin, Collins, and Button, 2014; Healthy Active Living and Obesity Research Group [HALO], 2017a; Sport for Life Society, n.d.). Nevertheless, given the heated discussions on PL, it is important to identify effective and efficient intervention strategies or programs to develop and promote PL among K-12 learners. This literature review aims to synthesize existing scholarship to inform future research, practice, and policy on PL-related interventions.

Methods

I conducted a conceptual literature review to address the research purpose. In this study, I started with a thorough literature search followed by article screening, organization, and analysis. These methodological procedures of the literature review are described below.

Literature Search

The literature review took place in three steps. Step one commenced with direct library search at a major public research university located in a southeastern U.S. state. Specifically, I conducted the direct search in the summer of 2018. The following keywords were entered individually or in combinations in the specified spaces of "Quick Search" and "Advanced Search" function: "physical literacy", "physical literate", or "physically literate" and "promot" or "interven" or "develop." I limited the search results to research articles, conference abstracts proceedings, and published/unpublished dissertations or theses on "children and/or adolescents" as

population of focus. Step two involved cross-checking the texts or references (appended in each published paper) cited in the included empirical studies/papers resulted from step one. For those relevant studies or programs listed in the references but are not retrieved through step one, I retrieved them through separate searches and downloads (i.e., Google scholar, retrieval from webpage, and electronic files available online). After completing steps one and two, I conducted individual searches using *Google*, *PubMed* and *PsychoInfo* to identify possible missing research articles or documents issued by accredited institutions/organizations using the same keywords (step three). The step one was repeated in October 2018 to include the more recently published articles. The inclusion criteria were pre-defined as: 1) must be written and published in English, 2) must be published between 1950 to October 2018, 3) must be defined or referred to as PL-specific, 4) must include an intervention/program to promote PL or its component(s), and 5) must report the intervention and/or its effect either in statistical or narrative outcomes. Articles that failed to meet all four criteria were excluded.

Literature Review, Coding and Theme Extraction

Literature review and screening began with carefully reading each full-text document. As I read each document, I extracted the essences of each document into a Microsoft Excel spreadsheet by authors' last name and initials of first and middle names, year of publication, journal name, research design, sample size, and main outcomes. I then re-read these papers to make sure there was no extraction error in the spreadsheet. I next sorted out the entries in the spreadsheet and categorized them by theme. For screening, empirical studies that specified the promotion, development, and/or intervention of PL in students regardless how PL was defined and where the study took place (e.g., in PE or youth sport), were included for coding. In addition, empirical studies that addressed promotion, development, and/or intervention of PL components in

the broader context of PL development were also included for coding and analysis. Conceptual papers that articulated approaches or strategies to promote PL or PL components (in the context of PL development) were also included. Articles and studies that went beyond the above criteria were excluded. For example, a study that examined components related to PL (e.g., FMS) but did not discuss FMS as a specific PL component would be excluded. Based upon these above methodological procedures, the following four themes emerged: (1) interventions for PL promotion, (2) interventions for promotion of PL-related components, (3) PL interventions for physical activity promotion, and (4) PL achievement across sub groups (i.e., grade and gender). The findings from the review are presented by these four themes.

Findings

Interventions for PL Promotion

A few studies were identified in the literature that specifically focused on interventional programs and strategies for PL promotion. A typical PL program can focus specifically on students' overall PL or PL components. The Physical and Health Education (PHE) Canada – Passport for Life is a program designed to promote PL (see Table A.1.; United Nations Educational, Scientific and Cultural Organization [UNESCO], 2015). This program involved 756 teachers and 4325 students (aged eight to 15 years old) across 330 classes. It focused on training teachers to offer quality lessons to increase students' knowledge, skill, fitness, awareness, and understanding related to PL (UNESCO, 2015). The PL was assessed by Passport for Life PL tool. By comparing data from pretest to posttest, statistically significant increases were observed in fitness, participation, interest, movement competency, skills, knowledge and understanding (Lodewyk & Mandigo, 2017; UNESCO, 2015). However, despite the large scale, this longitudinal study was carried out without a control group to examine the intervention effect.

The Youth-Physical Activity Towards Health (Y-PATH) program is a comprehensive school-based PL intervention in Ireland centering on 12 to 15 years old adolescents' PL achievement as represented by physical activity, FMS, health-related knowledge, heath-related activity, and psychosocial health (see Table A.1.; O'Brien, Belton, & Issartel, 2015). The design of the program was underpinned by youth physical activity promotion (YPAP) model (Chen, Welk, & Joens-Matre, 2014) to manipulate the predisposing, reinforcing, and enabling factors underlying the targeted PL related outcomes. The concerted efforts involved four intervening elements including students, teachers, parents/guardians, and a website. Intrapersonal level resources (i.e., teachers and parents/families) as well as organizational level resources (local sports clubs, environment, and facilities) were utilized to encourage and foster PL. Using a quasi-experiment design, the Y-PATH evaluation examined the eight-month program's intervention effects on physical activity (estimated by ActiGtaph-GT3X and Youth Physical Activity Questionnaire [YPAQ]) and FMS (assessed by Test of Gross Motor Development-1&2 [TGMD-1&2] and Victorian FMS manual) among 174 students (ranging from 12 to 14 years old) who were assigned to either the experimental or control group (O'Brien, Issartel, & Belton, 2013). Time and group effects were analyzed and the results showed significant time-by-treatment interaction effects on both physical activity and gross motor skill, all favoring the experimental group.

Another published study from the Y-PATH research group featured a randomized controlled trial to determine the program's intervention efficacy on PL and differences across sub groups (McGrane, Belton, Fairclough, Powell, & Issartel, 2018). A total of 534 participants were recruited and assigned randomly to experimental (exposure to Y-PATH) or control groups (regular PE once per week). PL related variables were assessed at three measurement points

(baseline, six months after baseline, and 10 months after baseline), including FMS (using TGMD-II and Victorian Fundamental Movement Skills Manual), cardiorespiratory fitness, and moderate-to-vigorous physical activity. The results showed significant time-by-treatment interaction effects of Y-PATH on locomotor skills, object control skills, and total FMS, all favoring experimental group at the posttest and retention measurement time points. Significant intervention effect was also observed in subgroups (by gender, weight status, and physical activity level) for the three variables.

Students' PL achievement has also been examined in relation to PE teachers' PL level. A randomized controlled study was designed to intervene PE teachers' PL (intervention = 35; control = 35) through a 50-hour continuing professional development (CPD) workshop (see Table A.1.; Sum, Wallhead, Ha, & Sit, 2018). The PE teachers' self-efficacy and PL level were measured prior to and after the eight-month CPD workshop. The participant sample consisting of 6300 students was randomized to experimental or control group, in which the experimental group were taught by the trained PE teachers (CPD attendees). Students' physical activity, autonomous motivation and physical activity enjoyment were measured at baseline, posttest and follow-up. The authors reported that PE teachers' PL and self-efficacy were hypothesized to increase as a result of the CPD workshop, which would influence their students' PL and physical activity as the outcomes of the reformed PE intervention. The detailed results of this study are currently still pending.

In summary, intervention studies targeting PL as an overarching construct are still scarce. The preliminary studies as summarized above have attempted to intervene on children and adolescents' PL as represented by multiple PL-related components including physical activity, FMS, fitness, heath-related knowledge, psychosocial health, and extra-curricular PA. However,

no studies have reported the intervention effect on an overall PL variable. Interestingly, all of these studies were contextualized in school settings with PE and/or PE teachers involved. This suggests the fundamental role of quality PE in PL promotion as pointed out in previous studies (Castelli, Barcelona, & Bryant, 2015; Castelli, Centeio, Beighle, Carson, & Nicksic, 2014; UNESCO, 2015). Interventional strategies adopted by these existing intervention studies range from using PL intervention programs or offering in-service PE teachers professional development to indirectly developing students' PL (e.g., developing PE teachers' PL and then their students' PL). The strength of this body of literature lies in the large scale of these studies by involving hundreds to thousands of students and dozens of PE teachers. However, those that employed the randomized controlled trials as the research design are still limited; and only two studies reported findings with detailed statistical descriptions. It is also noteworthy that there are significant discrepancies among the versions of PL assessment tools used across these programs to quantify PL. This added difficulties to my process of synthesizing the research results. Although intervention effects are observed across the studies, the dearth of studies on PL intervention based on reliable research designs makes it difficult to arrive at a conclusive statement affirming the intervention efficacy of these existing programs, workshops, and strategies on learners' overall PL achievement.

Interventions for Promotion of PL-Related Components in the Context of PL

Most of the existing PL intervention studies addressed certain components of PL (see Table B.1.). Roetert, Kovacs, Crespo, and Miley (2016) discussed that playing a sport (e.g., tennis) may enhance competence, confidence, and enjoyment of physical activity, which are essential for achieving the ultimate goal of PL: lifelong physical activity participation. Their argument is foundational for developing sport-based interventions that target individual PL-

related components. This section summarizes interventions for PL-related components in four facets: (1) interventions among early childhood, (2) interventions in school-based settings, (3) interventions in PE, (4) interventions in sport, and (5) intervention outside of school context.

Promoting PL-related components in early childhood. For early age children such as preschoolers, interventions have been designed to create environments to build physical competence, an indicator of PL. The Foundation Phase in Wales (FPW), for example, is a play-based PL promotion program for three to seven years old children (Wainwright, Goodway, Whitehead, Williams, & Kirk, 2018). This play-based naturalistic intervention focused on using a holistic approach to advancing students' learning. An empirical study examined the influence of the FPW program on physical competence (measured using TGMD-II), confidence (assessed using Pictorial Scale of Perceived Competence and Social Acceptance [PSPCSA], video, and field notes), and motivation (assessed using the Leuven Involvement Scale for Young Children [LISYC], video, and field notes) using both quantitative and qualitative methods (mixed methods design). The quantitative analysis results showed significant increases in locomotor skills, gross motor quotient, and perceived physical competence from time point one to three. The qualitative results also showed supportive results that complemented the quantitative outcomes. Similarly, the evaluation of the Healthy Start-Départ Santé program followed the cluster randomized controlled trial design over a six to eight months timespan. The program enabled educators and families to integrate healthy behaviors (i.e., physical activity measured using Actical accelerometer) and develop PL (i.e., FMS measured using TGMD-2) in the lives of preschoolers (aged three to five) enrolled in 61 childcare centers in Canada (Bélanger et al., 2016). The program capitalized on combined efforts of multiple partners and took into account factors at the intrapersonal, interpersonal, organizational, community, physical environment levels, as

informed by Social Ecological Model (McLeroy, Bibeau, Steckler, & Glanz, 1988). This program positively improved both physical activity and PL among children.

School-based PL components intervention. The viaSport British Columbia and the College of the Rockies conducted three studies to examine the effects of 1) lunch hour (LH) games program, 2) a mentorship program, and 3) a combination of the mentorship program and LH games on FMS (i.e., a physical competence indicator of PL) compared to the control group (Lavery, Sinker, & Pickering, 2017). The LH games program delivered games to four schools (grades one to six) with two 30-minute LH games sessions each week for 16 weeks (32 sessions in total). The eight-week mentorship program as well as the combination program of mentorship and LH games were implemented in four cities with only grade one to three receiving 16 sessions (two 30-minute sessions per week) for each group in total. Motor skills were assessed by selected items of the modified PLAY*fun* tools. The results demonstrated positive increase in overall PL score across all age groups (five to 11 years old) between two time-points both in control schools (n = 3) and LH games schools (n = 4). Similar trends were observed for mentorship as well as combination programs. In contrast, LH games groups increase more overall PL scores at posttest to each age populations (five to 11) than control group except the 9-year old; the largest increase disparity between control and LH games appeared in the eight years old (six point five). The increase of FMS in mentorship group was much greater than that in the mentor & LH games combined group.

Using game-oriented strategy to develop PL in school settings also showed efficacy in promoting FMS and physical activity. A study (Johnstone, Hughes, Janssen, & Reilly, 2017) examined how the Go2play Active Play as a school-based intervention would promote students' PL which was represented by physical activity level and FMS. The intervention was carried out

in Scotland from 2015 to 2016 with student participants (n = 172 and M_{age} = seven years old) recruited from seven elementary schools. Besides, another 24 students were recruited as the control group who didn't partake in any of the interventions. The participants' physical activity was measured at baseline and five-month follow-up, using objective measure (i.e., Actigraph-GT3X). Part of the participants from both control and experimental arms took the TGMD-II to assess FMS at baseline and follow-up. Results showed a significant time-by-treatment interaction effects on mean physical activity counts per minute, time percentage in sedentary behavior, low intensity physical activity, and medium to high intensity physical activity during school days. And, there were also significant interaction effect on gross motor quotient, percentile, locomotor skills scores and percentile. These results showed the Go2play Active Play intervention was effective in promoting physical activity and FMS.

PL components intervention in PE. Several studies with the purpose of developing PL-related components took place within the PE setting. For example, the Run-Jump-Throw (RJT) is a school-based program implemented in PE where the PE teachers were asked to provide tailored instructions of running, jumping, and throwing to develop students' movement skills, ranging from a fundamental movement patterns to the more advanced skills (Kozera, 2017). Students were encouraged to use purposeful play to facilitate creativity in applying imagery to movement. A quasi-experimental intervention lasting for eight weeks was conducted in eight schools (199 grade three and four students recruited) that were randomized to either the experimental (RJT-PE) and control groups (regular PE). The motor competence was measured using PLAY*fun*. The results showed a longitudinal improvements of overall motor competence (5.5%, $p < 0.01$), locomotor skills ($p < 0.05$), and object control skills ($p < 0.05$; Kozera, 2017). Both time ($p <$

0.01) and group effects on motor competence were observed in grades three and four, all favoring the RJT-PE group.

Another specific PE-based study for promoting PL-related components was conducted by Kiez (2015). This study focused on 211 students (nine to 12 years old) recruited from six schools to examine the efficacy of Circus Arts Instruction on PL (Kiez, 2015). The Circus Art Instruction involves applications of physiology and biomechanics, motor and explicit knowledge learning as well as explorations on intention and discourse. It also combines sport and artistic practice without reliance on certain norms that facilitates each instruction receiver being able to develop unique motor competence. The participants' PL was thoroughly assessed using the PLAY PL assessment tool series. The CIRCUS schools offered PE on average two point five to three times per week, while regular schools offered PE two point seven five to four point five times per week. Significant group-by-time interaction effects were observed in cognitive sub-domains of PL; and significant group effect was observed for the importance of movement (measured by PLAY*self*). A significantly greater number of physically active pursuits (measured by PLAY*inventory*) were found in the Circus PE schools. Within variables measured by PLAY*coach*, overall PL, cognitive sub-domains, environment participation, motor competence, and overall fitness were found to be significantly different between groups, but favoring the regular schools. Inconsistent results were found in PLAY*parent* measures, with PL Parent VAS and Balance favoring Circus schools and knowledge favoring regular PE schools. Significant group effect was observed for movement skills (15 out of 18 items) measured by PLAY*fun*, favoring the PE Circus group.

Chen, Hammond-Bennett and Hypnar. (2017) examined K-1 students' motor skill competence as a result of receiving the Coordinated Approach to Child Health (CATCH) PE.

The participants were 1223 to 1588 students (boys = 568 to 857) from nine elementary schools. Participants' motor skill competency in hand dribbling, running, underhand catching skills, and weight transferring were measured using the PE Metrics motor skill assessment rubrics over two intervention years (year one + year two). The results showed that in year one and year two intervention, the students demonstrated greater motor skill performances in all four skills. The students in the CATCH PE group performed significantly lower in year one than year two at assessment of all four skills. This study indicated that the PE-based interventional program using standardized PE curriculum can foster motor competency in four FMSs.

Another intervention study was conducted by Chen, Zhu, Mason, Hammond-Bennett, and Colombo-Dougovito. (2016) using the quality physical education teaching (QPET) practices to improve manipulative skill competency among fourth and fifth grade students. A total of 2709 fourth grade and 3420 fifth grade students were recruited. Sixty-three PE lessons were video-recorded and then coded using the assessing quality teaching rubrics (AQTR), which consists of four assessment dimensions including class management, task design, instructional guidance, and task presentation. Students' skill competence (i.e., represented by three manipulative skills) was assessed using the skill test rubrics from PE Metrics batteries. The authors found students' manipulative skill competency was significantly predicted by the four QPET dimensions. Boys showed more gains in striking and soccer skills while girls showed more gains in throwing skills. Overall, the students who received high quality QPET were more likely to demonstrate more skill competency than these who did not. This study informed that PE teachers' instruction largely determines students' achievement of learning manipulative skills.

PL-related components contextualized in sports. Youth sports are another channel through which students can develop their PL-related components. An empirical study conducted

by Mateus, Santos, Vaz, Gomes, and Leite (2015) examined how a PL based differential learning program would impact motor skill competency, and technical and tactical basketball skills. A total of 76 female and male college students (age: Mean ± SD = 20.4 ± 1.9) were randomly assigned to experimental (i.e., BasketCAL; n = 38) or control (n = 38) group. The Illinois Agility Test was used to assess the motor skills; Taco Bell skills challenge was used to assess technical abilities; and a four-on-four court basketball game was used to assess the tactical variables. The motor skills included the ability for turning and accelerating body movements at different angels and in different directions (Lennemann et al., 2013). The results showed a positive improvement in agility (*seconds*) in experimental group compared to the control group. The students in the experimental group had less unsuccessful actions (i.e., Triple threat position and Give-and-go) than the control group. In general, this program helped the players to overcome environment constraints and facilitated a better game decision making.

PL component intervention after school. The Y Kids Academy Program developed by YMCA-YWCA (YMCA: Young Men's Christian Association; YWCA: Young Women's Christian Association) offered both a summer camp and community-based programs to help children develop their knowledge of healthy lifestyle and to safely engage them to regular exercises (Lee et al., 2018). Students in the community program received two classes each week for a total of four weeks. The class has a 30-minute instruction and a series of exercises (i.e., strength training and cardio-training) lasting for one hour. The summer camp provided the same class for four days with a total of 30 hours. Participants were 163 children (M_{age} = 11.1; boys = 55%), and were measured using Canadian Assessment of Physical Literacy (CAPL). The knowledge was found to be significantly increased after the intervention.

As summarized above, there is a plethora of empirical studies that have examined the efficacy of interventions on PL-related components. A majority of these studies emphasized motor skills development in children and adolescents, which is an indicator of physical competence. This conforms to a previous meta-analysis showing that intervention for motor skill can significantly improve gross motor skills (Logan, Robinson, Wilson, & Lucas, 2011; Morgan et al., 2013). Fewer studies have intervened on other PL-related components such as fitness, knowledge and understanding, confidence, and physical activity behavior. These studies targeting PL-related components above demonstrated great variation in terms of research focus, research design, sample size, PL assessment tools, population (early childhood to college students), setting (e.g., PE, sport), location (U.S., Europe, etc.), and approach (curriculum and programming, instructional analysis). Such variations hamper the generalizability of these research findings. In addition, PE is considered as one of the most promising areas for putting forward PL related intervention followed by comprehensive school settings.

PL Interventions for Physical Activity Promotion

Certain PL components are associated with physical activity (Bélanger et al., 2018). Many PL intervention studies have focused on physical activity promotion: lifelong physical activity participation (see Table B.1.). The Canadian Sports for Life (CS4L) is pioneering the world for PL development. CS4L is supported by the Sport for Life Society with partners involving schools, sport clubs, community recreations, and families (Harber & Schleppe, 2010). By integrating recreation and sport, CS4L have three profound impacts: 1) equipping children with solid motor skills and confidence to stay active for life, 2) availability of environments to people from all walks of lives, and 3) supports of sport excellence (Vulliamy, 2011). PL intervention for physical activity promotion is also available in other countries.

In the UK, the Youth Sport Trust - Start To Move (STM) helps teachers' role in delivering PE instruction and promoting PL among children aged between four to seven years old (Youth Sport Trust, 2016, n.d.). A latest empirical study examining the impact of Bupa STM on children's total physical activity and FMS showed a 7% and a 11% increase, respectively (Youth Sport Trust, 2016). In addition, Sport Scotland developed an educational approach intervention (i.e., the Potential of Young People in Sport [PYPS] program) to promote lifelong physical activity and develop talent among children (Collins, Martindale, Button, & Sowerby, 2010). This two-year program was conducted in Scottish by a group of researchers who recruited 1060 participants. The intervention applied a physical and mental skill package in lessons and activity clubs to foster students' short-term activity levels as well as longer term changes in mental correlates for success (e.g., self-motivation, self-determination, and perceived competence). Activity level, self-determination, perceived competence, and self-motivation were significantly improved in the post measure suggesting the positive impact of PYPS program.

In New Zealand, the KIWI Sport program was launched by the Prime Minister John Key as a national initiative aiming at promoting school-age (one to 13 years old) children's participation in organized sport and physical activity/exercises, increasing availability and accessibility of sport opportunities, and developing necessary skills for effective sport participation (Kiwi Sport, n.d.). The nationwide program had 39% of its all projects implemented in increasing skills and 26% in increasing opportunities and competitions for participation; and 84% projects were run during school time and 16% during weekends and holidays (Kiwi Sport, n.d.). However, opposing tension existed that this initiative might have threatened the traditional PE (Pope, 2010).

In Canada and Australia, Nintendo Wii Games (active video games: VAGs) was considered an alternative approach to traditional physical activity. An empirical study exploring the impact of Nintendo Wii Games (VAGs) on children's PL revealed that six-week active video games (AVG) experiences (i.e., twice per week of at least 20 minutes of one AVG) could improve children's (aged between six to 12) PL in aiming and catching, improve boys' manual dexterity, decrease girls' pressure to engage in physical activity, and decrease perceived physical exertion. However, no significant longitudinal impact on physical activity behavior was observed. The AVGs experiences overall had positive impact on PL components (George, Rohr, & Byrne, 2016). MacNamara et al. (2011) argued that the PYPS program with developmental and educationally-oriented model offered fundamental skills that laid foundations for lifelong physical activity participation (MacNamara et al., 2011).

As shown above, only a few studies have examined the PL-related intervention effect on physical activity. Most programs designed single-group pre-to-post comparisons to identify longitudinal impact of their interventions; however, none of these studies involved a control group. This limited research design constrains researchers' ability to attribute the observed effects on physical activity to the PL-related interventions. Another observation I made is that most of these PL-related interventions on physical activity were delivered through PE and school settings. Clearly, current PL-related interventions on physical activity are short-term studies, rather than across multiple years or over a decade. Therefore, whether developing PL as a type of intervention can promote and sustain lifelong physical activity participation is still a puzzle. Longitudinal interventions studies in this topic are missing and warranted. Last but not the least, I also found that most of the pioneering sites of PL-based intervention programs for physical activity promotion are located in developed countries, which is consistent to The Aspen

Institute's conclusion (2015a). Thus, more research across populations from both developed and developing countries are needed.

Table B.1. Summary of PL interventions

Name (Year)	Program / Developers	Purpose	Intervention Descriptions	Participants	Main Findings
UNESCO (2015)	Passport for Life / Physical and Health Education (PHE) Canada	To support the development and advancement of PL among students and teachers.	Formative assessment program; Initial assessment and year-end assessment; the program provided teachers with supplementary trainings for implementing quality lessons that can promote students' awareness, understanding, knowledge, skill and fitness; 330 classes recruited.	756 teachers, 4325 students	Significant increases in some aspects of fitness, activity participation, interest for activity; non-significant increases in movement competency, feeling of confidence, importance, autonomy and enjoyment, as well as decrease in PA anxiety. Students demonstrated certain levels of life skills, and knowledge and understanding for healthy lifestyle.
O'Brien et al. (2013)	The Youth-Physical Activity Towards Health (Y-PATH) / Belton et al. (2014)	To develop adolescents' FMS, knowledge, PA, and psychosocial health with school-based interventions.	Underpinned by YPAP model; quasi-experimental design; lasted for eight months; PA and FMS were measured at three time points; four intervention components	174 students aged between 12 to 14 years old	Significant time and treatment interaction effect on PA and FMS.

(table cont'd.)

Name (Year)	Program / Developers	Purpose	Intervention Descriptions	Participants	Main Findings
McGrane et al. (2018)	Y-PATH / Belton et al. (2014)	To examine intervention efficacy and group level differences in response to Y-PATH.	Randomized controlled trial design. Duration: four months. Intervention arm (exposure to Y-PATH multi-components treatment; *n* = 236) and control arm (regular PE per week; *n* = 246). FMS was assessed using TGMD-2, also fitness and PA were measured.	482 students aged between 12 to 15 years old.	Time-to-intervention effects of Y-PATH on total object control, total locomotor, and total FMS.
Sum et al. (2018)	Continuing Professional Development (CPD) / NA	To examine intervention efficacy in promoting PE teachers' PL and subsequently how PE teachers from different intervention arms influence students' PL.	Randomized controlled trial design with two experimental sessions. Session one: intervention arm (50 hours of CPD training; *n* = 35), control arm (regular life; *n* = 35). Session two: students were randomly assigned to PE teachers from either intervention or control groups to receive different PE teaching lasting for eight months. Measurements: PE teachers (pre-to post assessments in PL and self-efficacy); students (pre-to-post assessments in PA, autonomous motivation and PA enjoyment).	70 PE teachers and 6300 students	NA

(table cont'd.)

Name (Year)	Program / Developers	Purpose	Intervention Descriptions	Participants	Main Findings
Wainwright et al. (2018)	Foundation Phase in Wales / Department for Children Education Lifelong Learning and Skills	To examine how the Foundation Phase program contributes to PL development.	Intervention underpinned by holistic approach of PL. Mix methods design involving quantitative and qualitative methods. Lasted for ten months with three time point measures. Intervention: play-based curriculum.	49 children aged three to seven	Significant improvements in locomotor skills, Gross Motor Quotient, and perceived physical competence scores
Bélanger et al. (2016)	Healthy Start-Départ Santé / Bélanger et al.	To promote daily physical activity and healthy eating habit for young children by engaging multi-level intervention.	Randomized control trail: experimental and control group. Underpinned by Comprehensive Behavior Change Models and Social Ecological Model. The intervention consisted of six components (i.e., implementation guide, partnerships, evidence-based resources, additional resource, training and mentoring, and knowledge development and exchange), and lasted for six to eight months.	Children aged between three to five from 61 childcare centers with at least 20 children recruited from each center.	NA

(table cont'd.)

Name (Year)	Program / Developers	Purpose	Intervention Descriptions	Participants	Main Findings
Lavery et al. (2017)	Mentorship & Lunch hour (LH) games / The viaSport British Columbia and the College of the Rockies	To examine how children's overall PL and FMS respond to LH games program, mentorship program, and a combination of the two programs.	The LH games program: 16 weeks, two × 30-minute sessions/week (32 sessions in total), four schools; mentorship program and the combined program: eight weeks, two × 30-minute sessions/week (16 sessions in total). The PL and FMS were assessed using CS4L PLAY*fun* tools.	LH games program: first to sixth graders, four schools; mentorship program and combined program: first to third graders, four cities.	More longitudinal increase in overall PL score across time points; mentorship program had more FMS increase than combined group.
Johnstone et al. (2017)	Go2Play active play intervention / Johnstone et al.	How the Go2play active play as a school-based intervention promotes students' PL (i.e., PA level and FMS).	Quasi-experimental design with pre-to-post measures. Duration: five months. Intervention arm (Go2play; n = 172), control arm (no intervention; n = 24). FMS was assessed using TGMD-2.	172 students from seven elementary schools with average age of seven years old.	Significant interactive time-to-treatment effect on mean counts per minute and time percentage in sedentariness, low intensity PA, and medium to high intensity PA for school day PA. And, there were also interactive effect on Gross Motor Quotient, percentile, locomotor skills scores and percentile.

(table cont'd.)

Name (Year)	Program / Developers	Purpose	Intervention Descriptions	Participants	Main Findings
Kozera (2017)	Running, Jumping, and Throwing (RJT) program / Sport Canada's Long Term Athlete Development	To examine the efficacy of RJT-PE in promoting PL.	Quasi-experimental design. Intervention arm: RJT-PE (n = 111; males = 65); control arm (n = 76; males = 42): regular PE. Protocol: eight weeks, three classes per week, class duration: 30 to 50 minutes; measurements: baseline (week prior to program implementation) & posttest (the week after the program). Lesson plan: 1. a group discussion and visualization exercise; 2. warm-up; 3. skill drills; 4. participatory task/game, and; 5. cool down/closure including reflection.	199 students aged between seven to 12	Both a time ($p <$ 0.01) and a group ($p < 0.05$) impact on motor competence for third (ES = 0.94) and fourth (ES = 0.67) grades favoring RJT-PE.

(table cont'd.)

Name (Year)	Program / Developers	Purpose	Intervention Descriptions	Participants	Main Findings
Kiez (2015)	Circus Arts Instruction / NA	To investigate how the Circus Arts Instruction incorporated PE improves students' PL measures.	Prospective, clustered quasi-experimental design. Intervention arm: Circus Art Instruction incorporated PE (three schools; *n* = 110); control arm: standard PE (three schools; *n* = 101). Protocol: PE Circus schools provided: circus arts instruction using minimal equipment (juggling, balance activities, clowning), "social circus" approach, physical and health education (PHE); 56.7 min/PE class, three times/week, 170 min/week. Standard PE schools provided standard PHE curriculum and delivery methods; 68 min/PE class, 3.3 times/week, and 225 min/week.	211 grade four and five students aged between nine to 12	A group effects favoring Circus Arts Instruction on: PLAY*Self* (cognitive sub-domains of PL, importance of movement), PLAY *Inventory* (number of physically active pursuits), PLAY *Coach* measures (overall PL, cognitive sub-domains and environment participation, motor competence, and overall fitness), PLAY*Parent* (VAS and balance) and PLAY*Fun* (movement skills).

(table cont'd.)

Name (Year)	Program / Developers	Purpose	Intervention Descriptions	Participants	Main Findings
Chen, Hammond, et al. (2017)	CATCH PE / University of California at San Diego, University of Minnesota, Tulane University, and The University of Texas Health Science Center at Houston School of Public Health	To promote children and adolescents' health-related fitness, physical competence, and PA attitude.	Pre- and post-test research design (two-year intervention). Year one: PE teacher training with four training components in CATCH School Workshop; PE teacher designed PE course plans and delivered a total of 37 CATCH PE lessons. Year two: PE teachers delivered 55 CATCH PE lessons.	1223 to 1588 elementary school students aged 5.5 on average	Four skills assessments (running, dribbling, weight transferring, and underhand catching) of motor skill competence increased significantly across cohorts with the year two scored the highest.
Lee et al. (2018)	Y Kid Academy Program / NA	To promote PA, knowledge, and health lifestyle.	Pre- and post -test research design. Community-based class (instruction and exercises): eight * 1.5 Hr; two/week * four weeks. Summer camp (same class): eight*1.5Hr (30 hours in total across four days).	163 children aged between nine to 14 (boys = 55%)	The healthy lifestyle knowledge at posttest was significantly improved compared to the pretest.

(table cont'd.)

Name (Year)	Program / Developers	Purpose	Intervention Descriptions	Participants	Main Findings
Mateus et al. (2015)	PL and differential learning program / NA	How a PL and differential learning program impact on motor, technical and tactical basketball skills.	Randomized controlled trial design. Intervention arm (BasketCAL; *n* = 38) and control arm (*n* = 38). Measurements: the Illinois Agility Test was used to assess the motor skills; Taco Bell skills challenge was used to assess technical abilities; and a four-on-four court basketball game was used to assess the tactical variables.	76 students with average age of 20.4 (*SD* = 1.9).	Positive improvement in agility (*seconds*) compared to the control group. The students in the experimental group had less actions (Triple threat position and Give-and-go) that performed unsuccessfully compared to the control group.
Vulliamy (2011)	Canadian Sports for Life (CS4L) / Sport for Life Society	To examine how intervention with recreation and sport promoted PL as a mean to physical activity participation.	Organized recreation and sport opportunities for youth were implemented in four aspects: schools, sport clubs, community recreations, and families.	Youth	Impacts of CS4P were found on: (1) equipping children with solid motor skills and confidence to stay active for life, (2) availability of environments to people from all walks of lives, and (3) supports of sport excellence.

(table cont'd.)

Name (Year)	Program / Developers	Purpose	Intervention Descriptions	Participants	Main Findings
Youth Sport Trust (YST) (n.d.)	YST UK – Start to Move (STM) / NA	To facilitate PE teachers' instruction and subsequently promote PL in children.	Helps teachers' role in delivering PE instruction and promoting PL. To implement Bupa STM on children's PA behavior and FMS.	Children aged between four to seven.	A 7% and a 11% increase in TPA and FMS, respectively.
KiWi Sport (n.d.)	KIWI Sport program / New Zealand Prime Minister John Key	To promote school age children's PA and sport engagements.	An estimate of 39% of its all projects implemented in increasing skills and 26% in increasing opportunities and competitions for PA participation; and 84% projects were run during school time and 16% during weekends and holidays.	Children aged between one to 13 years old.	NA
George et al. (2016)	Nintendo Wii Games (active video games: AVGs) intervention study / George et al.	To explore the impact of Nintendo Wii Games (active video games: VAGs) on children's PL.	Pre to post longitudinal research design. Six weeks of video-based games selected from the Nintendo Wii system pool, Wii Sport, Wii Sport Resort, Wii Play, and Just Dance Two. Students engaged in one of the four AVGs for at least 20 min twice/week.	Children aged between six to 12	The AVGs experiences have positive impact on PL.

(table cont'd.)

Name (Year)	Program / Developers	Purpose	Intervention Descriptions	Participants	Main Findings
Collins et al. (2010)	The Potential of Young People in sport (DPYPS) program / Sport Scotland	To promote lifelong PA and develop children's talent.	This two-year mix methods design program was conducted in Scottish by a group of researchers who recruited 1060 participants. The intervention applied a physical and mental skill package in lessons and activity clubs to foster students' short-term activity levels as well as longer term changes in mental correlates for success (e.g., self-motivation, self-determination, and perceived competence).	Senior primary school students (n = 487); year one (n = 312) and year two (n = 261) secondary school students.	At the posttest, activity level, self-determination, perceived competence, and self-motivation were significantly improved.

Note. PE: physical education; PL: physical literacy; PA: physical activity; TPA: total physical activity; FMS: fundamental motor skills; PLAY: physical literacy assessment for youth; TGMD: test of gross motor development: CATCH: Coordinated Approach to Child Health; YPAP: youth physical activity promotion (model); ES: effect size.

PL Achievement across Sub Groups

As a learning outcome, PL achievement may differ across sub groups such as between boys and girls and among older versus younger learners. Most of the existing research on group differences in PL achievement has targeted individual PL-related components rather than the overall PL. This body of research is summarized below.

PL achievement by gender. Longmuir et al. (2015) pointed out that gender should be taken into account when using the CAPL to measure PL. Their research compared gender differences in PL-related components and overall PL using the CAPL to measure knowledge and understanding, physical activity (favoring boys) and sedentary behavior, motivation and confidence (favoring boys), physical competency (favoring boys), and composite PL score (favoring boys). Another study found that boys showed higher achievement in some domains and sub domains but lower achievement in others than girls, although girls outperformed boys in overall PL achievement (Tremblay, Costas-Bradstreet, et al., 2018). The effect size for the gender differences ranged from being small (Cohen's $d = 0.05$) to moderate (Cohen's $d = 0.69$). Based on Bélanger et al. (2018), the overall PL score was significantly higher among boys than girls (Cohen's $d = 0.20$). In addition to the gender difference in overall PL achievement, a few idiosyncratic studies have examined gender differences in individual PL-related components. First of all, as an essential physical competence indicator for PL, FMS achievement is gender specific. For example, Sääkslahti et al. (1999) found gender moderated the associations among physical activity, body size, FMS, and Coronary Heart Disease risk factors. Also, the CS4L, in conjunction with Ophea, assessed PL in a youth sample ($N = 400$) before and after a 12-week intervention featured by quality school-based health and physical activity programs in Ontario. A significantly larger improvement of PL was observed in boys compared to girls. Another study

further found significant difference in FMS by gender, favoring boys (Kozera, 2017). Bélanger et al. (2018) reported significant gender effect on physical competence favoring boys with a small effect size (Cohen's $d = 0.17$). Similar effect of gender on FMS achievement is also observed in other studies (Chen, Hammond-Bennett, et al., 2017; Chen et al., 2016). However, Belton, Brien, Meegan, Woods, and Issartel. (2014) reported a gender effect on object control ($\eta^2 = 0.04$) but not locomotor; similarly, Butterfield, Angell, and Mason (2012) found that throwing and striking were significantly higher in boys than girls. In addition to physical competence, confidence in physical activity participation is also different between boys and girls (Lenney, 1977). A small effect size (Cohen's $d = 0.18$) of gender on motivation and confidence was found by Bélanger et al. (2018) favoring boys. A meta-analysis of 46 studies conducted by Lirgg (1991) with participants from elementary to college students showed a between-gender effect size of 0.40 for physical activity confidence favoring males. Another meta-analysis showed that gender is a significant moderator to the relationship between self-confidence and sport performance favoring males ($r = 0.29$) compared to females ($r = 0.04$). Last but not the least; boys and girls may also show different achievement of knowledge related to physical activity and fitness. Girls were found to have higher score in knowledge and understanding than boys (Cohen's $d = 0.14$; Bélanger et al., 2018). Thompson and Hannon (2012) found high school boys and girls possessed similar levels of health-related fitness knowledge. Other studies observed gender differences. DiLorenzo, Stucky-Ropp, Vander Wal, and Gotham (1998) found that fifth to ninth grade girls showed greater levels of exercise knowledge compared to boys. Similarly, Chen, Liu, et al. (2017) observed middle school girls outperforming boys in physical activity and health knowledge. For behavioral aspect, a significant gender effect was observed favoring boys (Cohen's $d = 0.22$; Bélanger et al., 2018).

PL achievement by age. The achievement of PL is also subject to age of the learners. Lavery et al. (2017) presented an increasing trend for overall PL scores and FMS across 5 to 11 years old. Kozera (2017) found that motor competence and movement vocabulary (locomotor, object control, object control, and balance) were significantly higher in older youth than their younger counterparts (grades three to four, grades four to eight, and grades eight to 12). Physical activity and health knowledge also appeared to increase by age during middle school grades (Chen, Gu, & Liu, 2018; DiLorenzo et al., 1998); this trend was replicated by Longmuir et al. (2018) for grades four, five, and six. Similarly, significant age effect was observed on behavioral domain of PL (i.e., meeting physical activity and sedentary behavior guidance; Bélanger et al., 2018). Additionally, Tremblay, Longmuir, et al. (2018) found grip strength, cardiorespiratory endurance, abdominal endurance and strength, and Canadian Agility and Movement Skill Assessment (CAMSA) score to be higher in older children, but trunk and lower body flexibility and physical activity to be lower than younger. Age was found to significantly differentiate motor skill favoring older groups (Butterfield et al., 2012).

Conclusions

This review paper summarized and synthesized the existing scholarship on PL related interventions. Following thorough literature reviews, I observe that extant intervention studies have primarily focused on PL components (e.g., FMS, knowledge, confidence, physical activity, and motivation, etc.) rather than overall PL. I also observe that certain PL components (e.g., FMS and physical activity) have been more studied than other components in the context of PL (e.g., knowledge and confidence). The quantity and quality of these intervention studies vary greatly across each other and also by themes. Nevertheless, as a globally heated topic, PL scholarship is still emerging and more intervention studies with the purpose for developing PL in

both developed and developing nations will further inform the pathway toward the physically educated individuals, namely the PL journey.

Some experts have brought up the importance of empirical evidence for successful PL-related intervention (Giblin et al., 2014), but a few reasons might have caused the lack of high-quality intervention studies. One reason could be that the intervention to increase PL is difficult to conceptualize and thus operationalize, as PL has been defined inconsistently by experts across fields/contexts (Giblin et al., 2014). To some scholars, PL is equal to FMS (e.g., developers of the 60 MKC), while others may include a wide variety of components in addition to FMS (e.g., CAPL). This diversity in PL definition adds disturbing noises for formulating a proper PL intervention. Meanwhile, rarely can a PL measurement instrument assign an overall score to quantify and depict a student's PL achievement; and instead, components of PL are often assessed separately. This also implies a gap that more evidences are needed for a conclusive statement that the overall PL is a manipulative variable to intervention. To some experts, PL is even unmeasurable through conventional research methods (Edwards, Bryant, Keegan, Morgan, & Jones, 2017; Whitehead, 2001). This further confuses researchers as to how to accurately and conveniently measure PL as a variable of interest.

The good news is that PL has been recognized globally as the main outcome of PE (as an end) as well as a continuum/journey to achieve a lifelong active lifestyle (as a mean to an end; Longmuir & Tremblay, 2016). Such plural conceptualization of PL widens the way for PL-oriented interventions. PE teachers and health teachers may choose to promote PL components in their programs as meaningful educational outcomes, or to promote physical activity and health behaviors by manipulating PL components.

Future Research Gap

The empirical PL interventions reviewed in this paper all seemed to be based on the assumption that PL is a composite intrapersonal-level construct that is malleable and measurable. A few questions that worth future research investigations are: (a) to what extent does the change of PL (and its components) lead to the change of physical activity participation? (b) to what extent does PL assessment tools reflect the actual level of PL? (c) whether different PL components would play the same or different role in contributing to development of the physically literate individuals and (d) how does PL differ across socioeconomic status and race/ethnicity. Up to now, existing research has shown varying efficacy across the various types of interventions. But rarely has these studies related improvement of PL to physical activity behavior change. In addition, based on the literature review, it seems that little study has been conducted to examine the effect of PL improvements on other benefits (e.g., academic performance) in addition to physical activity behavior. This is important because PL components may contribute to the development of the holistic child. Future study may explore the association between PL and academic variables. Lastly, through this literature review, I also spot a gap in the targeted populations that has insufficient investigation on middle school students who are at a critical stage for physical activity prevalence and skills development (Nader et al., 2008). Future research should measure and intervene in PL and PL related components among adolescents during middle school years.

APPENDIX B. PHYSICAL LITERACY ASSESSMENT INSTRUMENTS

CAPL–2 Questionnaire (page 121 - 127)

Assessment Batteries adopted from *CAPL-2* (HALO, 2017b)

What Do You Think About Physical Activity?

When we ask you about physical activity, we mean when you are moving around, playing, or exercising. *Physical activity* is any activity that makes your heart beat faster or makes you get out of breath some of the time.

Why are we asking you these questions?

We want to know what kids, like you, think about physical activity, sports, and exercise.

Please Remember:

There are no right or wrong answers! We only want to know what you think.

If you do not know an answer, please write your best guess.

There is no time limit, so please take all of the time you need.

Thank you for agreeing to become a participant of this study! Please respond to each question carefully and honestly. Information from you will be kept confidential. – *Yang Liu*

1. What is your gender?

- o Boy
- o Girl
- o Other

2. Are you Hispanic or Latino/Latina?

- o Yes
- o No

Skip To: Question 4, if Are you Hispanic or Latino/Latina? = Yes

3. What is your race?

- American Indian or Alaska Native
- Asian
- Black/African American
- Native Hawaiian or other pacific islander
- White
- Two or more races
- I don't know

4. Which grade are you in?

- 6^{th} Grade
- 7^{th} Grade
- 8^{th} Grade

5. Enter your student ID number (ask your teacher if you forget)_____.

6. Enter your birth date (MM/DD/YYYY) _____.

7. Please select which of the following best describes you.

- I am eligible for free lunch
- I am eligible for reduced-price lunch
- None of the above
- I don’t know

What's Most Like Me? (Instruction Page)

For each question, you have to read two sentences and then circle the sentence you think is **MORE LIKE YOU**.

Try the following **SAMPLE QUESTION**:

Some kids have one nose on their face	**BUT**	Other kids have three noses on their face

That shouldn't be too hard for you to decide!

Once you have circled the sentence that is more like you, then you have to decide if it is **REALLY TRUE** for you or **SORT OF TRUE** for you.

Here is another sample question for you to try. Remember, to answer the question you need to do two things:

(1) First, circle the sentence that is more like you.

(2) Then, put a check in the correct box if it is **REALLY TRUE** or **SORT OF TRUE** for you.

THERE ARE NO RIGHT OR WRONG ANSWERS, JUST TELL US WHAT YOU THINK IS **MOST LIKE YOU**!

Sample Question #2

Some kids like to play with computers □ REALLY TRUE for me □ SORT OF TRUE for me	**BUT**	Other kids don't like playing with computers □ REALLY TRUE for me □ SORT OF TRUE for me

Now you are ready to start filling in this form. **Remember, in each box you need to circle what is most like you and then check a box for "really" or "sort of" true.** Take your time and do the whole form carefully. If you have questions, just ask! If you think you are ready you can start now.

BE SURE TO FILL IN EACH FOLLOWING PAGE!

What's Most Like Me?

Some kids don't like playing active games □ REALLY TRUE for me □ SORT OF TRUE for me	**BUT**	Other kids really like playing active games □ REALLY TRUE for me □ SORT OF TRUE for me

Some kids are good at active games □ REALLY TRUE for me □ SORT OF TRUE for me	**BUT**	Other kids find active games hard to play □ REALLY TRUE for me □ SORT OF TRUE for me

Some kids don't have much fun playing sports □ REALLY TRUE for me □ SORT OF TRUE for me	**BUT**	Other kids have a good time playing sports □ REALLY TRUE for me □ SORT OF TRUE for me

Some kids do well in most sports □ REALLY TRUE for me □ SORT OF TRUE for me	**BUT**	Other kids feel they aren't good at sports □ REALLY TRUE for me □ SORT OF TRUE for me

Some kids don't like playing sports □ REALLY TRUE for me □ SORT OF TRUE for me	**BUT**	Other kids really enjoy playing sports □ REALLY TRUE for me □ SORT OF TRUE for me

Some kids learn to play active games easily □ REALLY TRUE for me □ SORT OF TRUE for me	**BUT**	Other kids find it hard learning to play active games □ REALLY TRUE for me □ SORT OF TRUE for me

Thank you for telling us which kids are most like you!

We just have a few more questions. Please turn to the following page.

Why are you active?

Boys and girls can be active by doing all sorts of things:

- Exercise (walking, keeping fit, or gym class) □
- Playing outside or doing active things (like playing in the park)
- Sports (like soccer, tennis, hockey, dance or swimming)

Below are some reasons why you might be active.

Please read each sentence and tell us **how true it is for you** (put a check in correct box).

I am active because…					
	Not true for me	Not really true for me	Sometimes true for me	Often true for me	Very true for me
being active is fun	□	□	□	□	□
I enjoy being active	□	□	□	□	□
I like being active	□	□	□	□	□

How do you feel about being active?

The next section has some sentences describing how girls and boys feel about BEING ACTIVE and DOING ACTIVE THINGS (like active games, playing outside and doing sports).

Please read each sentence and tell us how much each sentence is like you (put a check in correct box).

	Not like me at all	Not really like me	Sometimes like me	Quite a lot like me	Really like me
When it comes to playing active games, I think I am pretty good.	□	□	□	□	□
I think I do well at activities compared to other children.	□	□	□	□	□
When it comes to being active, I have good skills.	□	□	□	□	□

What do you know about physical activity?

Please circle **only one** answer for each question

1. How many minutes each day should you and other children do physical activities that make your heart beat faster and make you breathe faster, like walking fast or running? Count the time you should be active at school and also when you are at home or in your neighborhood.

a) 20 minutes

b) 30 minutes

c) 60 minutes or 1 hour

d) 120 minutes or 2 hours

2. There are many different kinds of fitness. One type is called endurance fitness, or aerobic fitness, or cardiorespiratory fitness. Cardiorespiratory fitness means:

a) How well the muscles can push, pull, or stretch

b) How well the heart can pump blood and the lungs can provide oxygen

c) Having a healthy weight for our height

d) Our ability to do sports that we like

3. Muscular strength or muscular endurance means:

a) How well the muscles can push, pull, or stretch

b) How well the heart can pump blood and the lungs can provide oxygen

c) Having a healthy weight for our height

d) Our ability to do sports that we like

4. If you wanted to GET BETTER AT A SPORT SKILL (like kicking and catching a ball), what would be the best thing to do?

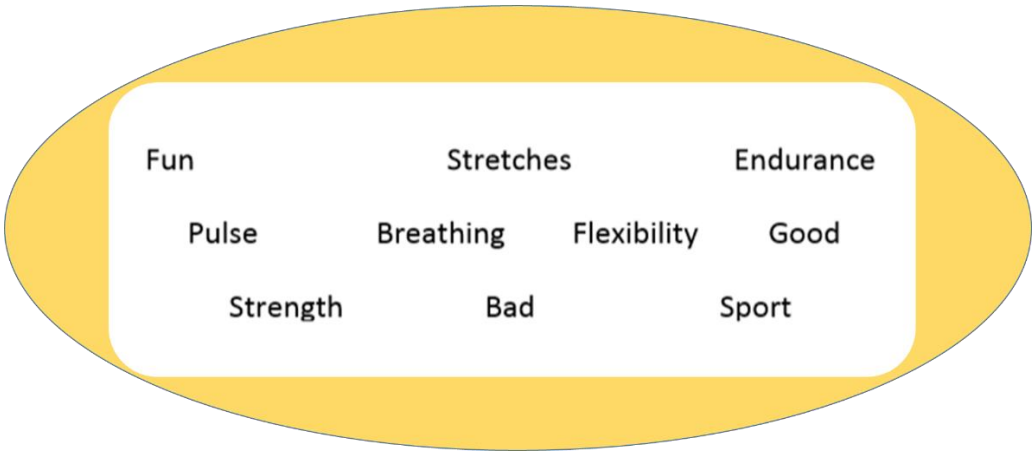
a) Read a book about kicking and catching a ball

b) Wait until you get older

c) Try exercising or being more active

d) Watch a video, take a lesson, or have a coach teach you how to kick and catch

5. This story about Sally is missing some words. Choose from the words in the box (as shown below) to fill in the missing words in the story (see below the box). Each word can only be used to fill one blank space in the story. There are more words than blank spaces, so not all words will be used.



Sally tries to be active every day. Running every day is good for her heart and her lungs. Sally thinks that physical activity is _____ and is also _____ for her. At her sport team's practice she does more running to improve her _____. The team also does exercises like push-ups and sit-ups that increase her _____. When cooling down, she _____ to improve her flexibility and slow her heart rate. After exercising, she checks her heart rate which is also called a _____.

6. During the past week (7 days), on how many days were you physically active for a total of at least 60 minutes per day? Count all of the time you spent doing activities that increase your heart rate or made you breathe hard.

I was active for 0 1 2 3 4 5 6 7 days [please circle 1 number]

Thank you very much for your participation. You have finished the questionnaire.

Assessment tool adopted from *CAPL-2* (HALO, 2017b)

Pedometer Instructions for Parent/Guardian

Dear Parent/Guardian,
Re: Pedometer Instructions for Parent/Guardian

Your child was given a pedometer today to measure their physical activity behavior as part of their participation in the Canadian Assessment of Physical Literacy. We have provided this instruction sheet as well as a step log for your child to fill out. Please help your child to complete the step log each day, and then return the log sheet along with the pedometer after the pedometer has been worn for 7 full days.

Step 1: Please have your child wear the pedometer for 7 days in a row; starting tomorrow when your child gets up in the morning (the day that your child received the pedometer is a practice day).

- To open the pedometer, pull the latch up and out.
- Please have your child open the pedometer and set it to zero each morning (before your child puts the pedometer on for the day) clear any steps from the previous day.
- Please ensure that the pedometer does not get wet as it is not water resistant.
- If your child needs to take off the pedometer at any time (i.e., swimming or to take a shower), please record the length of time that the pedometer was off on your child's log sheet. Put the pedometer back on as soon as your child is out of the water.
- The pedometer will not hurt your child and won't affect their play during sports. Your child should be able to wear it during practices and games. Ask the coach, instructor or the referee for permission to wear the pedometer this 1 week. If the coach, instructor or referee insists that the pedometer should not be worn, record the time that your child was not wearing the pedometer, the reason that it was not worn, and the activities that your child did while the pedometer was off on your child's log sheet.

Step 2: Please write down the number of daily steps every day at bedtime on the Step Log.

- Record the time of day when the pedometer was put on, the time it was removed and record the number of steps taken in the columns provided.
- Ask your child to leave the pedometer closed all day. The pedometer will only work when the lid is closed.
- **Please ask your child NOT to push the reset button at any time** other than before the pedometer is put on when getting out of bed in the morning. Pushing the reset button at any another time will clear the readings and make that day invalid. If this happens accidentally, please make a note of it on the log form and have your child wear the pedometer for 1 additional week day or weekend day (to replace the lost day).

Step 3: As soon as the 7 days are completed please return the completed Step Log and pedometer(s) immediately.

If you have any difficulties, please call: **225-236-2101** or email: yliu149@lsu.edu

Assessment tool adopted from *CAPL-2* (HALO, 2017a)

Common Questions (Assessment tool adopted from *CAPL-2* [HALO, 2017a]**)**

Question	Response
Can I wear the pedometer when playing a hockey/ soccer match (or other contact sports)	We want you to wear the pedometer as often as you can so try and wear it during all of your sport team practices and games. If your coach asks you to take the pedometer off, explain that you are participating in a physical literacy test and you are supposed to wear it as much as possible. But if your coach says you have to take it off, take the pedometer off and just record the time it was off and what you did while it was off on your log sheet.
Can I wear the pedometer when swimming?	The pedometer is not waterproof, so do not wear it if you are going to get it wet. Take it off just before you take a shower, a bath, or go swimming and then put it back on immediately after you get out of the water. Record how long the pedometer was off and what you did while it was off on your log sheet.
What if I press the reset button accidentally?	To avoid this happening, only open the pedometer at night just before you go to bed when you write down your steps. If you don't open the pedometer during the day there is no chance of you accidentally pushing the reset button and losing your steps for that day. If for some reason you do reset the pedometer to zero, write this on your log sheet, alongside how long you had worn the pedometer that day and any activities that you participated in. Please wear the pedometer an extra day to replace the missing information.
What if I have to wear dance/ gymnastics clothes and there is nowhere to put the pedometer?	You can put the pedometer on a belt or shorts that you wear over your dance/gymnastics clothes. Make sure that it is positioned in the right place (over your right hip) and that the belt is on tightly.
Will the pedometer hurt me?	The pedometer will not hurt you and will not break if you fall on it.
What if I forget to put the pedometer on in the morning? Can I put it on half way through the day?	Make sure you place the pedometer by your bedside at night so it is the first thing that you see when you get up in the morning. If you do forget to put it on first thing, put it on as soon as you remember and then record on your log sheet how long the pedometer was off for.

How to Record the Pedometer Score

- Pedometer data will be recorded on the participant log sheet.
- For each day indicate whether or not the pedometer was worn for the full day, and the number of steps taken.
- If the pedometer was taken off during the day, please tell us how long it was off for.

Pedometer Tracking Log

Practice day!	**Time on:** am/pm	**Time off:** am/pm	**# of steps taken**:_____	**Was the pedometer worn all day?** □ Yes, I never took it off □ No, how many hours missing:____

Day	**Date**	**Wake up time in the morning**	**Bed time in the evening**	**# of steps taken**	**Was the pedometer worn all day?**
1					□ Yes, I never took it off □ No, how many hours missing:____
2					□ Yes, I never took it off □ No, how many hours missing:____
3					□ Yes, I never took it off □ No, how many hours missing:____
4					□ Yes, I never took it off □ No, how many hours missing:____
5					□ Yes, I never took it off □ No, how many hours missing:____
6					□ Yes, I never took it off □ No, how many hours missing:____
7					□ Yes, I never took it off □ No, how many hours missing:____

Assessment tool adopted from *CAPL-2* (HALO, 2017a)

CAMSA Score Sheet

Test location: _____

Test Date: _____

Appraiser #1: _____

Appraiser #2: _____

ID Number									
Time(s)									
Two foot Jumping	3 two-foot jumps in and out of the yellow/purple/blue hoops								
	No extra jumps and no touching of hoops								
Sliding	Body and feet are aligned sideways when sliding in one direction								
	Body and feet are aligned sideways when sliding in opposite direction								
	Touch cone with low centre of gravity and athletic position								
Catching	Catches ball (no dropping or trapping)								
Throwing	Uses overhand throw to hit target								
	Transfers weight and rotates body								
Skipping	Correct hop-step pattern								
	Uses arms appropriately (alternates arms and legs, arm swinging for balance)								
One-foot hopping	Land on one foot in each hoop								
	Hops once in each hoop (no touching of hoops)								
Kicking	Smooth approach to kick ball and hit target								
	Elongated stride on last stride before impact								
Total									

Assessment tool adopted from *CAPL-2* (HALO, 2017a)

APPENDIX C. PE WORKSHOP MATERIALS

Workshop One

Total Duration: 20-30 minutes

Part I (Motivational Module; 5-10 minutes)

I. In this first part of the workshop, we are going to discuss some of your happy, exciting, and impressive moments during physical activities. Physical activities can be any sports, exercises, or recreation activities**. First, think about them, jot down on the notebook, and share with your partner and then with everyone else.**

- **Share your fun** (feel free to share your opinions voiced; be interactive and supportive)
  In the past week, do you have any fun in any physical activities? (write below)

  _____

  _____

II. Now, I would like you to think about difficulties or barriers for being physically active. For example, some people say they have no time/space/friends to go exercising; or they lack of skills in a sport. **What are some difficulties and barriers that prevent you from being active?**

- **Difficulties and barriers for being active**
  If you have any barriers or challenges to be active, what are these experiences (write below)

  _____

  _____

- **Your socialization with others**
  ***How does your social circle (like your friends) influence (both positively and negatively) everyone within the circle to perform physical activity (*note**, *physical activity can be sports, exercises for fitness, and/or recreational activities)* (write below)

  _____

  _____

Part II (Informational Module; 15-20mins)

In this second part of the workshop, let's learn some tips on how to improve your skill challenge performances; knowledge about physical activity, fitness, and health; and strategies to become more physically active.

- **Tips to improve performances in skill challenge**
  - **Warmup:** Do a good warmup before the test or any other exercises; try the test a few times before taking the real test.
  - **Jumping:** Let's use the jumping part of the test as an example. Make sure land on both feet at the same time; practice landing accuracy (don't touch the Hola hoops during jumping); and firm landing (no extra small jump after landing).
  - **Sliding:** Or, let's use the sliding part of the test as another example. When sliding, make sure you lower your center of gravity; shoulders, hips and feet all aligned; face the examiner to receive the softball and move perpendicular to the moving direction; don't go cross legs while sliding.

- **Knowledge of health-related fitness and physical activity**
  - ***Be active.*** How long should we be physically active each day? (wait for response before telling answer) Yes, you need to be active for at least 60 minutes each day. To improve health, your physical activity should let you breathe harder and your heart pump faster, you should sweat. To get 60 minutes, you can be active in school (like in PE, recess). You can also be active out of school (like doing sport, exercising at home, doing some yardwork or housework).
  - **Benefits:** There are lots of benefits of being active. Here are a few benefits: a. live longer; b. increase fitness and/or health; c. reduce / prevent heart disease; d. reduce / prevent high blood pressure; e. reduce / prevent certain cancers; f. protect against type-2 diabetes development; g. make bone and joints stronger; h. prevent obesity; i. relieve depression and anxiety; j. improve test scores.
- **Decision-making.** To remain physically active and receive health benefits from it, you need to learn how to make decisions.
  - For example, if you are interested in a sport and want to get better, you may seek help from coaches, PE teachers, on-line resources (e.g., video), or joining a team or club.
  - You may also choose to do some non-competitive, recreational activities such as hiking & jogging.
- **Improve health-related fitness.** How to improve health-related fitness? For example, how to improve flexibility and cardiorespiratory endurance.
  - **Flexibility**: stretch at least 3 days / week.
  - **Cardiorespiratory Endurance (cardio)**: jog/swim/bike or brisk walk for 30 minutes a day.

- **Active lifestyle: How to life an active lifestyle? Importantly, you need to know how to get yourself active. In other words, where are those physical activity opportunities?**
    - For example, you can get active time from recess, lunch hour, and breaks in school, other than just PE or sports.
    - If you do not play sports, do something fun that is active. Like go ride a horse, row a boat or kayak, or go hiking.

Please turn in your written response to the questions. Stay in touch with your partner after the workshop. Thank you. See you in a couple of weeks.

Workshop Two

Total Duration: 20-30 minutes

Part I (Motivational Module; 5-10 minutes)

I. Good to see everyone again. Like last time, we are going to first discuss your happy, exciting, and impressive moments during physical activities. Remember, physical activities can be any sports, exercises, or recreation activities**. Recall these positive experiences, write them down on the handout, and share with your partner and then with everyone else.**

- **Share your fun** (feel free to share opinions; be interactive and supportive)
  In the past week, did you have any fun in doing any physical activities? (write below)

  _____

  _____

II. Now, please recall any difficulties or barriers that you experienced for being physically active. For example, some people say they have no time/space/friends to go exercising; or they lack of skills in a sport. **Did you experience any difficulties and barriers that stopped you from being active?** (*If you still face the same problems as described in the first workshop, is there any changes made?*)

- **Write down the difficulties and barriers for being active below:**

  _____

  _____

- **Did you use any strategies to overcome these difficulties or barriers? What are they?**

  _____

  _____

- **Your socialization with others**
  How did your social circle (like your friends, family) influence (both positively and negatively) everyone within the circle to perform physical activity)? Can someone give a few examples?

  _____

  _____

Part II (Informational Module; 15 – 20mins)

In this second part of the workshop, let's learn some tips on how to improve your skill challenge performance; active-living knowledge; and strategies for being physically active.

- **Brief Review (30 seconds):** *Tips on skill challenge (warmup, jumping, sliding); knowledge (1-hour daily PA, health benefits); best decision (seek helps & appropriate exercise); ways to improve fitness (flexibility & endurance); PA opportunities (full use school time & clubs).*

- **New tips to improve skill challenge performance**
  - **Touch cones:** Knees bent; feet apart; lower gravity center
  - **Catching the ball:** Practice catching a softball (either two hand or one hand); do not trap the ball
  - **Targeting:** Quickly approach the target; aim at the target; quick throw with follow through; don't step over the throwing line

- **Active-Living Knowledge**
  - ***Health-related fitness.*** Health-related fitness includes: a. cardiorespiratory endurance; b. muscular strength; c. muscular endurance; d. flexibility; and e. body composition (Caspersen, Powell, & Christenson, 1985; Plowman & Meredith, 2013).
    - **Cardiorespiratory endurance** (also called: *cardio fitness*): the ability of the cardiovascular system (e.g., heart and lungs) to transport oxygen and fuel to the body (Caspersen et al., 1985; Plowman & Meredith, 2013). Who can give me a few examples of cardio activities? PACER is a common test to measure endurance.
    - **Muscular strength**: the amount of force certain skeleton muscles can produce (Caspersen et al., 1985; Plowman & Meredith, 2013). For examples, the bench press, deadlift, bicep curls, or leg press at a moderate or high intensity (e.g., less than 12 reps). The push-up is a common test to measure upper body muscular endurance and strength.
    - **Muscular endurance:** the ability that the skeleton muscles can perform continuously without fatiguing (Caspersen et al., 1985; Plowman & Meredith, 2013). Muscular endurance is tested when you do more than 12 reps of some light work. The sit-up is commonly used to assess muscular endurance, if you can do more than 12 reps in a row.
    - **Flexibility:** the ability of our joints to move through ranges of motion (Caspersen et al., 1985; Plowman & Meredith, 2013). Examples would be stretching muscles. Functional movements such as the lunge also demand good flexibility or mobility. Flexibility is most commonly tested using the sit-and-reach test.
    - **Body composition:** the amount of fat mass compared to the amount of lean muscle mass, bone and organs (Caspersen et al., 1985; Plowman & Meredith, 2013). You can use your weight and height to calculate body mass index.
- **Decision making.** To remain physically active and receive health benefits from it, you need to learn how to make decisions.

- One of the most important things in designing a personal workout is to set realistic / achievable goals by considering your fitness level.
- Before a workout, always warmup first.
- After the workout, do a cool-down.

- **Improve health-related fitness.** How to improve health-related fitness?
  - **Muscular strength**: weight training (e.g., at least 3 days / week).
  - **Muscular endurance**: pick a weight that you can do more than 12 reps x 3 sets.

- **Active lifestyle.** To live an active lifestyle, you need to know how to be active. Where are those physical activity opportunities?
  - Turn moderate activities to vigorous if time is limited.
  - Turn sedentary activities to moderate intensity activities.

Please turn in your written response to the questions. Stay in touch with your partner after the workshop. Thank you. See you in a couple of weeks.

Workshop Three

Total Duration: 20-30 minutes

Part I (Motivational Module; 5-10 minutes)

I. Good to see everyone at workshop #3. Like last time, we are going to first discuss your happy, exciting, and impressive moments during physical activities. Remember, physical activities can be any sports, exercises, or recreation activities**. Recall these positive experiences, write them down on the handout, and share with your partner and then with everyone else.**

- **Share your fun** (feel free to share opinions; be interactive and supportive)
  In the past week, did you have any fun in doing any physical activities? (write below)

  _____

  _____

II. Now, please recall any difficulties or barriers that you experienced for being physically active. For example, some people say they have no time/space/friends to go exercising; or they lack of skills in a sport. **Did you experience any difficulties and barriers that stopped you from being active?** (*If you still face the same problems as described in the second workshop, is there any changes made?*)

- **Write down the difficulties and barriers for being active below:**

  _____

  _____

- **Did you use any strategies to overcome these difficulties or barriers? What are they?**

  _____

  _____

- **Your socialization with others**
  How did your social circle (like your friends, family) influence (both positively and negatively) everyone within the circle to perform physical activity)? Can someone give a few examples?

  _____

  _____

Part II (Informational Module; 15-20mins)

In this second part of the workshop, let's learn some tips on how to improve your skill challenge performance; active-living knowledge; and strategies for being physically active.

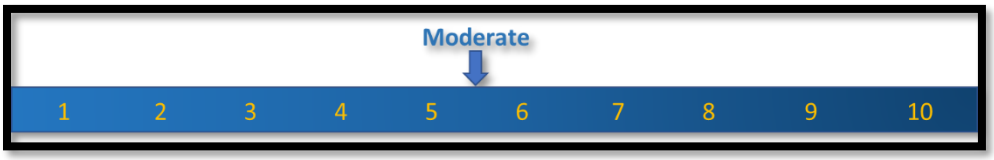
Brief Review (30 seconds): *Tips in skill challenge (touch cones, catching ball, and targeting); knowledge (health related fitness); best decision (set realistic goals, warmup, and usage of walking in warmup and cool-down); ways to improve fitness (strength & muscle endurance); PA opportunities (increase PA intensity if limited time & join community-organized activities).*

- **New tips to improve skill challenge performance**
  - **Throwing:** Do more practice to ascertain your most comfortable way to pitch (i.e., side arm throw), but make sure throwing arm from behind and hands over shoulder
  - **Skipping:** Do one step- one hop and step-hop approach; swing arm in opposite to your stepping side
  - **Hopping:** Use your leg of best performance; avoid touching the hoops by landing on the hoop's center point; hopping in a zigzag route to avoid backward hopping

- **Active-Living Knowledge**
  - ***Physical intensity.*** The physical intensity criterion for children of your age includes sedentary, low, moderate and vigorous physical activity.
    - **Sedentary:** "Any waking behavior characterized by an energy expenditure ≤1.5 METs while in a sitting, reclining or lying posture" (Tremblay, Aubert et al., 2017, p. 9). But it is not the same as physical inactivity.
    - **Light:** "Any activity with an energy expenditure between 1.5–3 MET, which includes both static (e.g. standing) and ambulatory activities" (van der Ploeg & Hillsdon, 2017, p. 2).
    - **Moderate & vigorous:** Also called collectively moderate- to -vigorous physical activity (MVPA).
      - ❖ ***Activities of moderate intensity (feeling)***

        Breathing is harder than normal; and heart rate is faster than normal (e.g., between 139 – 159 bpm; U.S. Department of Health and Human Services, 2018, p. 50-51).

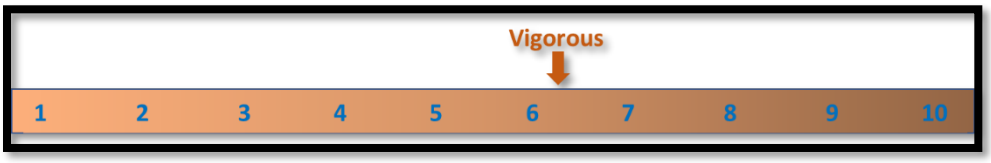
        If mark on a 0-10 scale, moderate intensity is around 5 to 6 (U.S. Department of Health and Human Services, 2018, p. 50-51).



      - ❖ ***Activities of vigorous intensity (feeling)***

        Breathing is much harder than normal; and heart rate is much faster than normal (e.g., above 159 bpm; U.S. Department of Health and Human Services, 2018, p. 50-51).

If mark on a 0-10 scale, vigorous intensity is between 7 to 8 or above (U.S. Department of Health and Human Services, 2018, p. 50-51).



- **Decision making.** To remain physically active and receive health benefits from it, you need to learn how to make decisions.
  - The purpose of doing warmup and cool-down is because body needs low intensity activity such as active/static stretching or walking to better regulate blood flow for working muscles and body temperature.
  - Don't do muscle-strength or muscle-endurance workout set by set without any interval, leave for 30 to 60 seconds between each set.

- **Improve health-related fitness.** How to improve health-related fitness?
  - **Prevent cardiovascular diseases**: keeping on personalized fitness plan, like regular exercising most of the days in each week.

- **Active lifestyle.** To live an active lifestyle, you need to know how to be active.
  - Chose the best you can to be active in life: Running > jogging > brisk walking > walking > standing > stretching > siting > inclining > lying.
  - Replace video game with active game.

Please turn in your written response to the questions. Stay in touch with your partner after the workshop. Thank you. See you in a couple of weeks.

Workshop Four

Total Duration: 20-30 minutes

Part I (Motivational Module; 5-10 minutes)

I. Good to see everyone at our last workshop. Like last time, we are going to first discuss your happy, exciting, and impressive moments during physical activities. Remember, physical activities can be any sports, exercises, or recreation activities**. Recall these positive experiences, write them down on the handout, and share with your partner and then with everyone else.**

- **Share your fun** (feel free to share opinions; be interactive and supportive)
  In the past week, did you have any fun in doing any physical activities? (write below)

  _____

  _____

II. Now, please recall any difficulties or barriers that you experienced for being physically active. For example, some people say they have no time/space/friends to go exercising; or they lack of skills in a sport. **Did you experience any difficulties and barriers that stopped you from being active?** (*If you still face the same problems as described in the last workshop, is there any changes made?*)

- **Write down the difficulties and barriers for being active below:**

  _____

  _____

- **Did you use any strategies to overcome these difficulties or barriers? What are they?**

  _____

  _____

- **Your socialization with others**
  How did your social circle (like your friends, family) influence (both positively and negatively) everyone within the circle to perform physical activity)? Can someone give a few examples?

  _____

  _____

Part II (Informational Module; 15 – 20mins)

In this second part of the workshop, let's learn some tips on how to improve your skill challenge performance; active-living knowledge; and strategies for being physically active.

Brief Review (30 seconds): *Tips in skill challenge (throwing, skipping, and hopping); knowledge (PA intensity); best decision (importance of warmup and cool-down & interval between strength training); ways to improve fitness (prevent cardio disease: personal workout); PA opportunities (preference for active lifestyle & video game vs. active game).*

- **New tips to improve skill challenge performance**
  - **Approaching:** In order to be ready to kick the soccer to the target, anticipate your steps and make appropriate adjustment in approaching to the ball; elongate (make larger stride) last step right before you kick; try to ascertain the number of steps in approaching to the soccer during practice
  - **Continuity:** When doing the current task skill, get mentally ready for the next skill to secure smooth transition
  - **No hesitance:** Whenever you make a mistake, don't pause! Just go ahead. Speed also matters.
  - **Practicing:** Do more practices for all the skills either in a row or separately

- **Active-Living Knowledge**
  - ***Determine your intensity (objective).*** Ways to objectively determine the physical activity intensity include tracking time, measuring distance, calculating speed, counting repetition & weight, or taking heartrate during the activity.
  - ***Appropriate tools.*** Intensity: heart rate monitor or take pulse (carotid artery).
- **Decision making.** To remain physically active and receive health benefits from it, you need to learn how to make decisions.
  - To lose body fat, one of the best choices is running & jogging or other aerobic activities.
  - To be better in a certain sport item, you may consider 4 principles:
    - Specificity: train what you expected to train
    - Progression: don't over-exert your body at beginning; try from appropriate workout
    - Overload: To make fitness gain, you need add more load than usually is
    - Individualization: training should cater everyone's uniqueness
  - A good workout plan should include activities for aerobic endurance, muscle strength/endurance, and flexibility.
- **Improve health-related fitness.** How to improve health-related fitness?
  - **Flexibility**: stretching exercise (e.g., at least 3 days / week).

- **Endurance**: moderate or vigorous intensity long-distance jogging/swimming/cycling or brisk walking to maintain an increased heartrate for 30 minutes (e.g., recommended 5 days / week). These activities are also called aerobic activity.
- **Strength**: weight training (e.g., at least 3 days / week).
- **Muscular endurance**: Using weight machines & free weights exercises with correct technique, slow motion, less weight, more repetitions, and movements usually going through full range of joint.
- **Prevent cardiovascular diseases**: keeping on personalized fitness plan, like regular exercising most of the days in each week.

- **Active lifestyle.** To live an active lifestyle, you need to know how to be active. Where are those physical activity opportunities?
  - Have more outdoor activities than staying at home in the weekends.
  - Join a stable group for active games.
  - Keep in mind 1-hour activities may be achieved by accumulating even minute-long activity.

Please turn in your written response to the questions. Stay in touch with your partner after the workshop. Thank you. See you in a group interview in a near future.

APPENDIX D. IRB PERMISSION & FORMS

ACTION ON PROTOCOL APPROVAL REQUEST

Institutional Review Board
Dr. Dennis Landin, Chair
130 David Boyd Hall
Baton Rouge, LA 70803
P: 225.578.8692
F: 225.578.5983
irb@lsu.edu
lsu.edu/research

TO: Senlin Chen
Kinesiology

FROM: Dennis Landin
Kinesiology

DATE: July 1, 2019

RE: **IRB#** 4255

TITLE: Middle School Students' Physical Literacy: An Exploratory Study

New Protocol/Modification/Continuation: New Protocol

Review type: Full ___ Expedited _X_ **Review date:** 6/25/2019

Risk Factor: Minimal ___X___ Uncertain _____ Greater Than Minimal_____

Approved_____X_____ **Disapproved**_____

Approval Date: 7/1/2019 **Approval Expiration Date:** 6/30/2020

Re-review frequency: (annual unless otherwise stated)

Number of subjects approved: 360

LSU Proposal Number (if applicable)**:**

By: Dennis Landin, Chairman _____

PRINCIPAL INVESTIGATOR: PLEASE READ THE FOLLOWING –
Continuing approval is CONDITIONAL on:

1. Adherence to the approved protocol, familiarity with, and adherence to the ethical standards of the Belmont Report, and LSU's Assurance of Compliance with DHHS regulations for the protection of human subjects*
2. Prior approval of a change in protocol, including revision of the consent documents or an increase in the number of subjects over that approved.
3. Obtaining renewed approval (or submittal of a termination report), prior to the approval expiration date, upon request by the IRB office (irrespective of when the project actually begins); notification of project termination.
4. Retention of documentation of informed consent and study records for at least 3 years after the study ends.
5. Continuing attention to the physical and psychological well-being and informed consent of the individual participants, including notification of new information that might affect consent.
6. A prompt report to the IRB of any adverse event affecting a participant potentially arising from the study.
7. Notification of the IRB of a serious compliance failure.
8. **SPECIAL NOTE: When emailing more than one recipient, make sure you use bcc.**

**All investigators and support staff have access to copies of the Belmont Report, LSU's Assurance with DHHS, DHHS (45 CFR 46) and FDA regulations governing use of human subjects, and other relevant documents in print in this office or on our World Wide Web site at http://www.lsu.edu/irb*

Child Assent Form

I, _____, agree to be in this study to find ways to promote children' s physically active lifestyle. I have been informed of the research purpose and processes of this study. I understand that I will be asked in PE classes to complete tests, surveys, and body height & weight measurement. I understand that I will be expected to run hard in the 20m PACER running test. I may be selected to participate in a workshop during PE and focus group interviews. I understand that I have the right to decline or stop being in the study at any time without getting in trouble.

Child's Signature: _____ Age: _____ Date: _____

Witness* _____ Date: _____

* (N.B. Witness must be present for the assent process, not just the signature by the minor.)

Please contact us if you have questions about this form.

Institutional Review Board
Dr. Dennis Landin, Chair
130 David Boyd Hall
Baton Rouge, LA 70803
P: 225.578.8692
F: 225.578.5983
irb@lsu.edu | www.lsu.edu/irb

Child Assent Form adapted from and approved by Institutional Review Board, Office of Research & Economic Development, Louisiana State University

Parental/Guardian Consent Form for Student Participants

1. Study Title: Middle School Students' Physical Literacy: An Exploratory Study
2. Purpose and Procedure of the study: (1) To describe the status of middle school students' physical literacy (PL) achievement as well as achievement across demographic and anthropometric groups including gender, grade, race/ethnicity, and weight status, and (2) to inquire and reveal the different journeys toward physical literacy as a result of receiving a tailored pedagogical workshop across a two-month time period.

Students will report using a questionnaire their demographic information. The assessment of PL achievement will take place in PE classes to measure students' fundamental motor skills, fitness (Progressive Aerobic Cardiovascular Endurance Run [PACER] and Isometric Plank Hold), self-reported daily physical activity behavior, self-reported motivation and confidence, knowledge and understanding for health, physical activity and fitness, daily step count (using pedometer). A few students (n = 24) will be selected to participate in an informational workshop (4 sessions over 8 weeks) to learn how to improve PL. They will participate in three semi-structured focus group interviews (15–30-min/each). The PE classes will be observed by a trained data collector each week.

3. Risks: There is minimal risk involved in participating in this study. All tests are commonly used in school PE classes and have been used in most Louisiana elementary and middle schools. Three of the tests are physical tests, including assessments of fundamental motor skills, PACER (a 20-meter back and forth run test), and isometric plank hold. While the fundamental motor skill assessment is not physically demanding, the PACER and isometric plank hold tests may require significant physical exertion. Students will be asked to put forth maximal effort on these tests. The PE teachers will be reminded of the potential risk of participating in tests and therefore prompted to keep students' readiness for exercise in file. The PE teachers will also be instructed to teach students the correct forms and techniques of each required performance to avoid or minimize injuries from test engagement.

4. Benefits: Each school will be provided with PE equipment worth of $800 as incentive to participate in the study.

5. Investigators: The following investigators are available for questions about this study: Dr. Senlin Chen; Mr. Yang Liu and Mr. Baofu Wang; M-F, 8:00am - 4:30pm; 225-578-5960

6. Performance Site: A designated location within the participating schools (classroom, gymnasium, office, or conference room).

7. Number of subjects: 150 – 300 student participants.

8. Subject Inclusion: Students in 6^{th} and 7^{th}grades from the participating schools will be invited to participate in the study for student-level data.

9. Exclusion Criteria: Children who do not meet the grade level requirements, or who has been recommended by doctor for physical, health or mental issues.

10. Right to Refuse: Subjects may choose not to participate or to withdraw from the study at any time without penalty or loss of any benefit to which they might otherwise be entitled.

11. Privacy: Results of the study may be published, but no names or identifying information will be included in the publication. Subject identity will remain confidential unless disclosure is required by law.

12. Financial Information: There is no cost for participation in the study, nor is there any compensation to the subjects for participation.

13. Signatures: The study has been discussed with me and all my questions have been answered. I may direct additional questions regarding study specifics to the investigators. If I have questions about subjects' rights or other concerns, I can contact Dennis Landin, Institutional Review Board, (225) 578-8692, irb@lsu.edu, www.lsu.edu/irb. I agree to participate in the study described above and acknowledge the investigator's obligation to provide me with a signed copy of this consent form.

Subject Signature: _____ Date: _____

Parent's Signature: _____ Date: _____

The parent/guardian has indicated to me that he/she is unable to read. I certify that I have read this consent from to the parent/guardian and explained that by completing the signature line above he/she has given permission for the child to participate in the study.

Signature of Reader: _____ Date: _____

Identifiers might be removed from the identifiable private information or identifiable biospecimens. After removal, the information or biospecimens may be used for future research studies or distributed to another investigator for future research studies without additional informed consent.

Yes, I give permission (Signature): _____

No, I do not give permission (Signature): _____

Physical Activity Readiness Questionnaire (PAR-Q)

As your child is to be a participant in this project, please complete the following PAR-Q for your child for his/her readiness for physical activity participation. **Any information contained herein will be treated as confidential.**

1. Has your doctor ever said that your child has a heart condition and that your child should only do physical activity recommended by a doctor? **YES NO**
2. Does your child ever experience chest pain during physical activity? **YES NO**
3. Does your child ever lose balance because of dizziness or do they ever lose consciousness? **YES NO**
4. Does your child have a bone or joint problem that could be made worse by a change in their physical activity participation? **YES NO**
5. Does your child have uncontrolled asthma (i.e. asthma that is not easily controlled by an inhaler? **YES NO**
6. Is your doctor currently prescribing any medication for your child's blood pressure or a heart condition? **YES NO**
7. Do you know of any other reasons why your child should not undergo physical activity? This might include diabetes, a recent injury, or serious illness. **YES NO**

If you have answered **NO** to all questions then you can be reasonably sure that your child can take part in the physical activity requirement of this project. Answering **YES** to any of the questions may lead to your child's withdrawal from the project. Alternative appropriate educational activities will be arranged for your child to participate.

In the event that medical clearance must be obtained before my child's participation in an exercise session, I agree to contact medical professionals and obtain written permission prior to the commencement of the exercise activity, and that the permission be given to the instructor.

In signing this form, I, the parent/guardian of the aforementioned child, affirm that I have read this form in its entirety and I have answered the questions accurately and to the best of my knowledge.

Child's name: _____

Parent/guardian's print name:_____

Parent/guardian's signature:_____

Date:_____

PAR-Q Form adapted from and approved by Institutional Review Board, Office of Research & Economic Development, Louisiana State University

Research Participation Consent

1. Study Title: Middle School Students' Physical Literacy: An Exploratory Study
2. Purpose and Procedure of the study: (1) To describe the status of middle school students' physical literacy (PL) achievement as well as achievement across demographic and anthropometric groups including gender, grade, race/ethnicity, and weight status, and (2) to inquire and reveal the different journeys toward physical literacy as a result of receiving a tailored pedagogical workshop across a two-month time period.

Students will report using a questionnaire their demographic information. The assessment of PL achievement will take place in PE classes to measure students' fundamental motor skills, fitness (Progressive Aerobic Cardiovascular Endurance Run [PACER] and Isometric Plank Hold), self-reported physical activity daily behavior, self-reported motivation and confidence, knowledge and understanding for health, physical activity and fitness, daily step count (using pedometer). A few students (n = 24) will be selected to participate in an informational workshop (4 sessions over 8 weeks) to learn how to improve PL. They will participate in three semi-structured focus group interviews (15–30-min/each). The PE classes will be observed by a trained data collector each week.

3. Risks: There is minimal risk involved in participating in this study. All tests are commonly used in school PE classes and have been used in most Louisiana elementary and middle schools. Three of the tests are physical tests, including assessments of fundamental motor skills, PACER (a 20-meter back and forth run test), and isometric plank hold. While the fundamental motor skill assessment is not physically demanding, the PACER and isometric plank hold tests may require significant physical exertion. Students will be asked to put forth maximal effort on these tests. The PE teachers will be reminded of the potential risk of participating in tests and therefore prompted to keep students' readiness for exercise in file. The PE teachers will also be instructed to teach students the correct forms and techniques of each required performance to avoid or minimize injuries from test engagement.

4. Benefits: Each school will be provided with PE equipment worth of $800 as incentive to participate in the study.

5. Investigators: The following investigators are available for questions about this study:
Dr. Senlin Chen; Mr. Yang Liu and Mr. Baofu Wang; M-F, 8:00am - 4:30pm; 225-578-5960
6. Performance Site: A designated location within the participating schools (classroom, gymnasium, office, or conference room).
7. Number of subjects: 150 – 300 student participants.
8. Subject Inclusion: Students in 6th and 7thgrades from the participating schools will be invited to participate in the study for student-level data.

9. Exclusion Criteria: Children who do not meet the grade level requirements, or who has been recommended by their doctor for physical, health or mental issues.

10. Right to Refuse: Subjects may choose not to participate or to withdraw from the study at any time without penalty or loss of any benefit to which they might otherwise be entitled.

11. Privacy: Results of the study may be published, but no names or identifying information will be included in the publication. Subject identity will remain confidential unless disclosure is required by law.

12. Financial Information: There is no cost for participation in the study, nor is there any compensation to the subjects for participation.

13. Signatures: The study has been discussed with me and all my questions have been answered. I may direct additional questions regarding study specifics to the investigators. If I have questions about subjects' rights or other concerns, I can contact Dennis Landin, Institutional Review Board, (225) 578-8692, irb@lsu.edu, www.lsu.edu/irb. I agree to participate in the study described above and acknowledge the investigator's obligation to provide me with a signed copy of this consent form.

School Administrator Signature: Faye Soupe Date: 8/8/19

15. The following section appears on the parental and participant consent forms. It appears here only for your information and your signature is not needed.

For research involving the collection of identifiable private information or identifiable biospecimens one of the following must be listed on the consent form:

Identifiers might be removed from the identifiable private information or identifiable biospecimens. After removal, the information or biospecimens may be used for future research studies or distributed to another investigator for future research studies without additional informed consent.

Yes, I give permission_____
Signature

No, I do not give permission_____
Signature

OR

Your information or biospecimens collected as part of the research, even if identifiers are removed, may be used or distributed for future research

Yes, I give permission_____
Signature

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Zhang, P., Liu, Y., Gu, X., & Chen, S. (2019). Toward active living: SES- and race-based disparities in knowledge and behaviors. *Journal of Racial and Ethnic Health Disparities, 7*(2), 374-382.

CURRICULUM VITAE

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EDUCATION BACKGROUND

2017-2020	Ph.D. in Kinesiology	Louisiana State University
2015-2017	Ph.D. studies in Kinesiology	Iowa State University
2010-2013	M.Ed. in Physical Education	Jiangxi Normal University
2005-2009	B.Ed. in Physical Education and Coaching	Tianjin University of Sports
2002-2005	High school studies	Zibo No.1 High School
1998-2002	Middle school studies	Boshan No.7 Middle School

Dissertation Title: *Characterizing middle school students' physical literacy: A sequential mixed-methods study*. - Advised by Dr. Senlin Chen (Chair), Dr. Alex Garn, Dr. Melinda Solmon, Dr. Youn Kyoung Kim, Dr. Jacqueline Bach

RESEARCH EXPERTISE AND INTEREST

Physical literacy; physical education (PE) curriculum and learning; and physical activity and health promotion in youth

PROFESSIONAL APPOINTMENT/EMPLOYMENT

08/2017-05/2020	Teaching and Research Assistant, Louisiana State University
08/2015-05/2017	Teaching and Research Assistant, Iowa State University
09/2012-12/2012	Teaching Assistant, Jiangxi Normal University, China
2010-2012	Swimming Club Director, Boshan Workers' Cultural Palace, China
2004-2009	Swimming Coach, Youth Sports School of Boshan District, China

PUBLICATIONS

Published Peer-Reviewed Scholarly Journal Articles

1. **Liu, Y.,** Chen, S., & Gu, X. (in press). Learning differences in physical education: Students' attitude, knowledge, and behavior across two middle school cases. *Journal of Teaching in Physical Education.*

(ISSN / eISSN: 0273-5024 / 1543-2769; Social Science Citation Index & Science Citation Index Expanded)

2. **Liu, Y.,** & Chen, S. (in press). Physical literacy: Definitions, assessments and interventions. *European Physical Education Review*.
(ISSN / eISSN: 1356-336X / 1741-2749; Social Science Citation Index)

3. **Liu, Y.,** & Chen, S. (2020). Students' knowledge and behaviors for active living: A cross-sectional survey study. *Journal of Teaching in Physical Education, 39*(2), 206-215. doi: 10.1123/jtpe.2018-0352.
(ISSN / eISSN: 0273-5024 / 1543-2769; April 30th, 2020; Social Science Citation Index & Science Citation Index Expanded)

4. Zhang, P., **Liu, Y.,** Gu, X., Chen, S. (2020). Toward active living: SES- and race/ethnicity-based disparities in knowledge and behaviors. *Journal of Racial and Ethnic Health Disparities, 7*, 374-382. doi: 10.1007/s40615-019-00666-w.
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5. Chen, S., **Liu, Y.**, & Welk, G. (2019). Using a hybrid design to analyze effectiveness and implementation of a refined energy-balance education module for upper elementary physical education. *e Journal de la Recherche sur l'Intervention en Education Physique et en Sport (eJRIEPS; Research Journal on Intervention in Physical Education and Sport), 3*, 108-124. https://doi.org/10.4000/ejrieps.3648
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6. Chen, S., Gu, X., & **Liu, Y.** (2018). To move more but sit less: The roles of students' attitude and knowledge. *European Physical Education Review, 25*(3), 731-744. doi: 10.1177/1356336X18767309
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7. Chen, S., **Liu, Y.,** & Schaben, J. (2017). To move more and sit less: Does physical activity/fitness knowledge matter? *Journal of Teaching in Physical Education, 36*, 142-151. doi: 10.1123/jtpe.2016-0137
(ISSN / eISSN: 0273-5024 / 1543-2769; April 3rd, 2017; Social Science Citation Index & Science Citation Index Expanded)

Peer-Reviewed Scholarly Journal Articles (in progress)

8. Chen, S., **Liu, Y.**, Androzzi, J. N., Wang, B., & Gu, X. (revised and resubmitted). High intensity interval training (HIIT)-based fitness education in middle school Physical Education: Is it feasible and efficacious? *Journal of Teaching in Physical Education*.
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9. **Liu, Y.**, & Chen, S. (in preparation). Characterizing middle school students' physical literacy: A sequential mixed-methods study. *Journal of Teaching in Physical Education.*

Published Peer-Reviewed Scholarly Journal Articles (in Chinese)

10. Li, J., Ge, Y., & **Liu, Y.** (2014). Mechanical characteristics of the elbow joint flexors and extensors of excellent rock climbers. *Journal of Physical Education, 21*(1), 133-137. doi: 10.16237/j.cnki.cn44-1404/g8.2014.01.029
(ISSN: 1006-7116; Jan 28th, 2014)

11. Yu, C., Huang, W., Jian, Y., **Liu, Y.,** Xiao, X., & Xu, C. (2013). Experimental research on the influence of interactive teaching between academic and professional sports postgraduates. *Hubei Sports Science, 32*(9), 838-841.
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(ISSN: 1003-983X; Sept 15th, 2013)

12. Hong, Z., Yu, Y., **Liu, Y.,** & Ding, J. (2012). Analysis of the cultural features of the 7th national city games. *Physical Education Review, 31*(264), 38-40.
(ISSN: 1004-2644; Jan, 2012)

13. Yu, G., **Liu, Y.,** & Zou, H. (2011). Current situation research on the characteristics of difficult movements performed by Chinese advanced competitive aerobics athletes. *Inner Mongolia Sports Science and Technology, 24*(4), 72-73.
http://mall.cnki.net/magazine/Article/NMTK201104032.htm
(ISSN: N/A; 4th quarter, 2011)

PEER-REVIEWED BOOK CHAPTERS

Chen, S., Gu, X., & **Liu, Y.** (in press). Funding before and after-school physical activity programs. In R. Martinnen & E. Centeio. *Approaches to before and after school physical activity programs.* Routlege Publications: New York.

PRESENTATIONS
Research Presentations at National or International Conferences

2015-present (in English)

1. Chen, S., **Liu, Y.**, Androzzi, J., Wang, B., & Gu, X. (2020). *Feasibility of a HIIT-based fitness education unit in middle school physical education*. Paper accepted for oral presentation at the 2020 AERA annual meeting, San Francisco, CA. [conference cancelled due to COVID-19; turned to virtual platform]

2. **Liu, Y**., Chen, S. (2020). *Physical literacy: Definitions, assessments, and interventions*. Paper presented at 2020 Health and Physical Literacy Summit, Birmingham, AL.

3. **Liu, Y.**, Androzzi, J., Wang, B., Gu, X., & Chen, S. (2020). *Teaching students PAF knowledge through HIIT-based physical education*. Paper accepted for oral presentation at the 2020 SHAPE America national convention, Salt Lake City, UT. [conference cancelled due to COVID-19; proposal available in online platform]

4. **Liu, Y.**, Wang, B., Androzzi, J., Gu, X., & Chen, S. (2020). *Examining the effect of a HIIT-based fitness education curriculum*. Paper accepted for oral presentation at the 2020 SHAPE America national convention, Salt Lake City, UT. [conference cancelled due to COVID-19; proposal available in online platform]

5. Wang, B., **Liu, Y.**, & Chen, S. (2020). *A scoping review of physical education curriculum interventions*. Paper accepted for presentation at the 2020 SHAPE America national convention, Salt Lake City, UT. [conference cancelled due to COVID-19; proposal available in online platform]

6. Chen, S., & **Liu, Y.** (April 9th, 2019). *Middle school students' profiles of physical activity and fitness (PAF) knowledge*. Paper presented (oral presentation) at the 2019 ICSPAH annual symposium at Tampa, FL. **** Won the outstanding oral presentation award.** URL (pp. 16): http://icspah.net/uploadfile/upload/2019033100214868.pdf

7. Chen, S., **Liu, Y.**, Androzzi, J., Wang, B., & Gu, X. (September 25th, 2019). Integrating High Intensity Interval Training (HIIT) for Fitness Education: A Pilot Intervention. Paper presented (oral) at 2019 IPHPE conference, Columbia, SC.
URL (pp. 6): http://www.meetabout.org/iphpe/wp-content/uploads/sites/66/2019/09/iphpe-conference-program-web.pdf

8. **Liu, Y.,** & Chen, S. (April 9th, 2019). *Describing adolescents' profiles of physical activity and sedentary behaviors*. Paper presented (roundtable oral presentation) at the 2019 ICSPAH annual symposium at Tampa, FL. **** Won the outstanding oral presentation award.**
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9. **Liu, Y.,** Chen, S., & Gu, X. (April 12th, 2019). *Students' attitude, physical activity, and knowledge: The effects of gender, grade, and ethnicity***.** Paper presented (poster presentation) at the 2019 SHAPE America national convention, Tampa, FL. (published in *Research Quarterly for Exercise and Sport, 90*[sup1], A-5-A-171; ISSN / eISSN: 0270-1367 / 2168-3824; Science Citation Index Expanded & Social Science Citation Index; April 11th, 2019)
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10. **Liu, Y.,** Chen, S., & Gu, X. (April 12th, 2019). *The relationships between attitude toward physical education, physical activity and sedentary behavior, and knowledge among middle school students*. Paper presented (poster presentation) at the 2019 SHAPE America national convention, Tampa, FL. (published in *Research Quarterly for Exercise and Sport, 90*[sup1], A-5-A-171; ISSN / eISSN: 0270-1367 / 2168-3824; Science Citation Index Expanded & Social Science Citation Index; April 11th, 2019)

URL (pp. A-98): https://www.tandfonline.com/doi/full/10.1080/02701367.2019.1591919

11. **Liu, Y.,** Chen, S., & Gu, X. (April 6th, 2019). *The importance of learners' attitude toward physical education and knowledge for active-living: Evidence from two middle schools in two difference states*. Paper presented (roundtable oral presentation) at the 2019 AERA annual meeting, Toronto, Canada.
URL:
https://convention2.allacademic.com/one/aera/aera19/index.php?cmd=Online+Program+View+Paper&selected_paper_id=1436701&PHPSESSID=so7eq62tarp87i7cpe430jqrs4
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12. Tao, C., Zou, J., **Liu, Y.,** & Chen, S. (April 9th, 2019). *Square dance participation behaviors: Does motive matter?* Paper presented (roundtable oral presentation) at the 2019 ICSPAH annual symposium at Tampa, FL.
URL (pp. 24): http://icspah.net/uploadfile/upload/2019033100214868.pdf

13. Zhou, J., Tao, C., **Liu, Y.,** & Chen, S. (April 9th, 2019). *The participation and motives for square dance in Chinese cities: A descriptive study.* Paper presented (roundtable oral presentation) at the 2019 ICSPAH annual symposium at Tampa, FL.
URL (pp. 24): http://icspah.net/uploadfile/upload/2019033100214868.pdf

14. **Liu, Y.,** & Chen, S. (March 22nd, 2018). *Establishing Classification Criteria for an Energy Balance Knowledge Test for Fourth and Fifth Grade Children*. Paper presented (poster presentation) at the 2018 SHAPE America national convention, Nashville, TN. (published in *Research Quarterly for Exercise and Sport, 89*[sup1], A-i-A-210; ISSN / eISSN: 0270-1367 / 2168-3824; Science Citation Index Expanded & Social Science Citation Index; March 20th, 2018)
URL (pp. A-178): https://www.tandfonline.com/doi/full/10.1080/02701367.2018.1453732

15. Chen, S., Welk, G., Lee, J., Wolff, M., & **Liu, Y.** (March 16th, 2017). *Learning energy balance knowledge in Switch Physical Education lessons.* Paper presented (poster presentation) at the 2017 SHAPE America national convention, Boston, MA. (published in *Research Quarterly for Exercise and Sport, 88*[sup1], A-i-A-176; ISSN / eISSN: 0270-1367 / 2168-3824; Science Citation Index Expanded & Social Science Citation Index; March 9th, 2017)
URL (pp. A-156): https://www.tandfonline.com/doi/full/10.1080/02701367.2017.1301746

16. **Liu, Y.,** Chen, S., & Schaben, J. (March 15th, 2017). *Identifying knowledge for adolescents to move more and sit less.* Paper presented (poster presentation) at the 2017 SHAPE America national convention, Boston, MA. (published in *Research Quarterly for Exercise and Sport, 88*[sup], A-i-A-176; ISSN / eISSN: 0270-1367 / 2168-3824; Science Citation Index Expanded & Social Science Citation Index; March 9th, 2017)
URL (pp. A-88): https://www.tandfonline.com/doi/full/10.1080/02701367.2017.1301746

17. Chen, S., Bai, Y., **Liu, Y.,** Schaben, J., Vazou, S., Welk, G., & Hong, D. (2016). *Trend analysis of youth physical activity, sedentary behavior, and motivation.* Paper presented at the 2016 ICSPAH annual forum, Minneapolis, MN.

18. **Liu, Y.,** Chen, S., Schaben, J. (2016). *The association between fitness/physical Activity knowledge and physical activity among eighth grade students*. Paper presented at the 2016 ICSPAH annual forum, Minneapolis, MN. **** Won the outstanding oral presentation award**

19. Schaben, J., Chen, S., Welk, G., Vazou, S., **Liu, Y.,** & Bai, Y. (June 4th, 2016). *Physical activity and fitness knowledge: What do they know and does it impact behavior?* Paper presented at the 2016 ACSM national convention, Boston, MA. (published in *Medicine and Science in Sports and Exercise, 48*[5S], 1068; ISSN / eISSN: 0195-9131 / 1530-0315; Science Citation Index Expanded; May 2016)
doi: 10.1249/01.mss.0000488213.96102.ad

Before & after 2015 (in Chinese)

20. Tao, C., Zhou, J., & **Liu, Y.** (Nov 1st, 2019). Self-regulation among elderly females: A study based on square dancers. Paper presented (oral presentation; ID: 2578) at The 11th National Convention on Sports Science of China, Nanjing, Jiangsu, China.
doi: 10.26914/c.cnkihy.2019.030579

21. **Liu, Y.,** Huang, W., Vincent, D., & Ge, Y. (July 20th, 2012). *The Sports Elements Gleaning in Chinese Traditional Jade Culture*. Paper presented at the ICSEMIS conference, London. Glasgow, U.K. URL: https://images.congrex.com/reglogos/Posters%20FINAL.pdf

22. Yin, Y., Huang, W., **Liu, Y.,** Xi, Y., Yin, G., & Liu, X. (2011). *The Research on the Characteristics of Body Shape and Physical Power of the Male Athletic Aerobics Players from the National Aerobics Training Base*. Proceedings from the 22nd Pan-Asian Congress of Sports & Physical Education. Beijing, China: World Academic Union (World Academic Press). VolumeVI, pp. 282-285. (July 22nd – 24th, 2011; Index to Scientific & Technical Proceedings [ISTP])

23. **Liu, Y.,** Huang, W., Ge, Y., Hong, Z., Zheng, Q., Lu, H., Ding, J., & Liu, Y. (2011). *An Innovative Design for Making the Multi-Functional Isokinetic Exerciser*. Proceedings from *the 22nd Pan-Asian Congress of Sports & Physical Education*. Beijing, China: World Academic Union (World Academic Press). VolumeVII, pp. 345-348. (July 22nd – 24th, 2011; Index to Scientific & Technical Proceedings [ISTP])

Non-Research Professional Presentations for PE Practitioners at Local or Regional Conferences

24. Domingue, E., Cummings, C., **Liu, Y.,** & Chen, S. (Nov 7th, 2019). HIIT Fitness Education: A University and School Partnership. Presentation delivered at the 2019 LAHPERD State Convention, Baton Rouge, LA.

25. Lukowski, R., Velthoff, J., **Liu, Y.,** & Chen, S. (Jan 2017). *Adopting SWITCH PE to Focus on Energy Balance Education.* Workshop presented at 2017 SHAPE America Central District annual convention, Cedar Falls, IA.

26. Shepherd, K., Chen, S., & **Liu, Y.** (2017). *How physically fit are middle school students? Status of fitness and group differences*. Research Poster Presented at 2017 ISU Honors Poster Presentation, Ames, IA; funded by the Iowa State Honors Program.

27. Velthoff, J., Lukowski, R., **Liu, Y.,** & Chen, S. (Jan 2017). *Incorporating Strength Training into PE Curriculum*. Workshop presented at 2017 SHAPE America Central District annual convention, Cedar Falls, IA.

RESEARCH PROJECTS PARTICIPATION

1. *Efficacy and Implementation of HIIT PE for Fitness Education*
   Role: Project Manager and Research Assistant 02/19/2020 - 01/31/2021
   This study examines the efficacy and implementation of the HIIT-based fitness education (HIIT = high intensity interval training) (version 2.0). My primary responsibilities for this study include collecting (formative & summative program evaluation), processing, and analyzing data. Due to COVID-19 crisis, the project is temporarily halted. The findings from this research project will be disseminated at national conferences and peer-review journals. The project was funded by the NIH (R21PA-16-161; grant No. R21HD090513 [sub $427,440; total $275,000]) and Helen "Bessie" Silverberg Pliner Professorship.

2. *Middle school students' physical literacy: An exploratory study*
   Role: Project Designer, Manager and Research Assistant 07/2019 - 05/2020
   Mentored by Dr. Senlin Chen, I designed this dissertation project to (1) describe the status of middle school students' physical literacy level across demographic and anthropometric groups, and (2) to inquire and reveal the different journeys toward physical literacy between low-achieving and high-achieving students as a result of receiving a tailored 8-week pedagogical workshop. My primary responsibilities include study designing and organizing, collecting, processing and analyzing data. I disseminated part of the findings in 2020 Health and Physical Literacy Summit, Birmingham, AL. The project was funded by LSU Dean's Circle Grant Program ($3000).

3. *A pathway toward active-living: Utility of a HIIT-based physical education module*.
   Role: Project Manager and Research Assistant 02/2019 - 05/2019
   Led by Dr. Senlin Chen, the project is designed to evaluate the implementation and feasibility of a high intensity interval training (HIIT; version 1.0) fitness education unit in middle school physical education (PE). My primary responsibilities include collecting, processing and analyzing data. I also contributed to dissemination of the findings. The project was partially funded by a NIH R21 (R21PA-16-161; grant No. R21HD090513 [sub $427,440; total $275,000]) grant and the Helen "Bessie" Silverberg Pliner Professorship held by Dr. Chen.

4. *School-based Wellness project at Pedagogical Kinesiology Lab of Louisiana State University*
   Role: Research Assistant 03/2016 - 02/2018

Led by Dr. Senlin Chen, this project examines the relationship among physical activity, attitude toward PE, physical activity and fitness (PAH) knowledge in middle school students. My primary responsibilities include collecting, processing and analyzing data. I also contributed to dissemination of the findings. The project was funded by the LSU Helen "Bessie" Silverberg Pliner Professorship held by Dr. Chen.

5. *Implementation of SWITCH P.E. lessons (PE Module) for energy balance education.*
   Role: Research Assistant 08/2015 - 03/2017
   Led by Dr. Senlin Chen, this project examines the implementation and efficacy of SWITCH P.E. in upper elementary schools. We collected data from four elementary schools in Iowa. I helped process data and created summative and formative feedback for the program. I also helped disseminate the findings through conferences presentations and publications. The project was in part funded by the SHAPE American/AAHPERD Research Grant (PI: Dr. Senlin Chen) and a USDA NIFA grant (PI: Dr. Gregory Welk; grant No. 2015-68001-23242, project No. IOWW-2014-08390 [sub 2014-17/2017-20, $21,904; total $2,851,196]).

6. *To move more and sit less: Does physical activity/fitness knowledge matter?*
   Role: Research Assistant 03/2016 - 08/2016
   Led by Dr. Senlin Chen, this project examines the relationship between knowledge and behaviors related to physical activity and/or sedentary behavior in youth. I helped process and analyzed data, and coauthored conference presentations and a journal article published in *Journal of Teaching in Physical Education.*

7. *School-based survey project at Pedagogical Kinesiology Lab of Iowa State University*
   Role: Research Assistant 12/2015 - 03/2016
   Led by Dr. Senlin Chen, this cross-sectional study examined the relationship among physical activity, attitude toward PE, and physical activity/fitness knowledge in youth recruited from middle schools in Iowa. My primary responsibilities for this study included collecting, processing, and analyzing data. I also contributed to the dissemination of findings to SHAPE America annual Convention and JTPE. The study was funded by AAHPERD/SHAPE Research Grant for Early Career Investigators ($5000).

8. *Research of the Feasibility of Mutual Assistant Teaching Model between Academic and Professional Sports Postgraduates*
   Role: Primary Investigator 05/2012 - 05/2013
   Led by Professor Huang Wenying, my master's degree advisor, entrusted me to write this project scheme and study on this topic. I was also in charge of experimental implementation, data processing and writing paper. We published a paper *Experimental Research on the Influence of Interactive Teaching between Academic and Professional Sports Postgraduates* on Hubei Sports Science. Won 2nd prize in 2012 National Sports Teaching and Training Paper Reports.

9. *Research on Implementing Physiology Experiment Extra-Curriculum Based on FLASH Simulation via Internet Service*
   Role: Primary Investigator 09/2012 - 12/2012
   I was the author and organizer of this project; and its research achievements are application-

oriented, so, no paper is published based upon it.

10. *Research and Application of the Evaluation of Teenagers' Daily Physical Activities Level and of the Key Technological Methods of Measuring the Energy Expenditure in Youth.*
    Role: Research Assistant 06/2010 - 12/2012
    In this project, our research team used ActiGraph GT3X to capture the 150 middle school students' energy expenditure, and measured indictor of BMI, routine blood and liver function. With these variables, we try to prove the practical value of energy consumption measuring instrument and any relationship between energy consumption and health status.

TEACHING EXPERIENCES

01/2020-05/2020	KIN2512 Classroom Culture Organization	LSU
01/2020-05/2020	KIN4520 Psychosocial Aspects of Physical Activity	LSU
08/2019-12/2019	KIN4520 Psychosocial Aspects of Physical Activity	LSU
01/2019-05/2019	KIN7900 Introduction to Research Methods (TA)	LSU
08/2017-05/2020	KIN1155 Beginning Jogging	LSU
08/2015-05/2017	KIN101 Swimming One (for beginners)	ISU
08/2015-05/2017	KIN102 Swimming Two (for advanced swimmers)	ISU
08/2015-05/2017	KIN108 Aquatic Fitness	ISU
09/2012-12/2012	Community Health Education (TA)	JNU

PROFESSIONAL ENGAGEMENT & SERVICES

Member, Society of Health and Physical Educators (SHAPE America).
Member, International Chinese Society for Physical Activities and Health (ICSPAH)
Member, International Physical Literacy Association (IPLA)
Member, Louisiana Association for Health, Physical Education, Recreation and Dance (LAHPERD)
Ad Hoc Reviewer, Journal of Teaching in Physical Education (JTPE) (2019 - present)
Ad Hoc Reviewer, 2020 ICSPAH Research Symposium (2019 - 2020)
Invited Peer Reviewer, 2021 American Educational Research Association (AERA) Annual Meeting (2020 – 2021)

HONORS & AWARDS

1. Outstanding Oral Presentation Award, 5th Symposium of ICSPAH (International Chinese Society for Physical Activities and Health), April 10th, 2019. Tampa, Florida (04/10/2019).
2. Outstanding Poster Presentation Award, 3rd Symposium of ICSPAH (International Chinese Society for Physical Activities and Health), April 5th, 2016. Minneapolis, Minnesota (04/2016).
3. 2nd prize in 2012 National Sports Teaching and Training Paper Reports (Certificate No: 201207153), national level (07/2012).
4. Excellent Graduate Student Award, Jiangxi Normal University (12/2011).

OTHER SKILLS

Data Processing & Analysis using Microsoft Office, SPSS, R, SAS, Nvivo, Qualtrics.